POWER

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The KILOWATT and the HORSEPOWER

THESE two units are in common use for measuring or expressing amounts of power, the kilowatt the world over, the horsepower in English-speaking countries.

The kilowatt came into use with electricity, but it is a mechanical unit, 10,000,000,000 ergs per second, just as the horsepower is 550 foot-pounds per second.

The watt is also a function of the electromotive force and the rate of flow of an electric current. The output of electric machinery and the passage of electric current may, therefore, be easily computed from or directly indicated by the electrical instruments.

Naturally, the capacity or output of generators and the distribution and consumption of current have come to be expressed in kilowatts and kilowatt-hours.

But why rate a generator in kilowatts and the turbine or engine that drives it in horsepower? Why rate a generator in kilowatts and the motors that it runs in horsepower, or a motor in kilowatts and an engine running perhaps the same kind of a load in horsepower?

The International Electrotechnical Commission's Advisory Committee No. 14 on the Rating of Rivers is planning to give first consideration, at its meeting at Stockholm this month, to the development of definitions of terms, and the use of the kilowatt and kilowatt-hour as units in which the flow and power potentialities of rivers are to be recorded is being seriously considered.

Where metric units of space, volume, and density are used this will be quite simple and natural. If, by the use of English units, the energy comes out in foot-pounds the divisors to reduce it to the kilowatt units would be more awkward than even our 550, 33,000, and 1,980,000, but it would involve no more work, perhaps, than the growing necessity for the use of conversion factors due to the retention of two systems of units.

F. R. Low

EDITORIALS

The 1936 World Power Conference

LIKE a great city seen from the deck of an outbound ship, the Second World Power Conference recedes from view. And, again like the city, it gains perspective and significance from the growing distance.

American engineers, in particular, will look back and ponder, for on their shoulders rests much of the responsibility for the third plenary session, to be held here in 1936.

Two aspects of the Berlin conference stand out: The magnitude of it all, and the thorough organization of the work of the German committee. About fifteen hundred delegates were expected; more than four thousand came. Yet the sessions went forward and there were seats for all at the banquets.

At the grand banquet more than three thousand sat down to dinner in the Sport Palace, and entertainment was provided by more than a thousand performers in native costume. The technical sessions were actively attended, as were the many excursions to points of interest, power plants, and manufacturing establishments.

The setting for the conference was inimitable. There is little likelihood that Americans may give such a fine show in 1936. They can, however, live up to the high standard set by their German confrères in the matter of solid contributions to engineering progress and international co-operation.

Electrical Transmission Vs. Freight on Coal

IS IT CHEAPER to transmit energy electrically or to pay the freight on coal to a plant located near the center of the load? Such a question is involved in most superpower enterprises. The answer must necessarily depend upon a number of conditions, primary of which are the transmission voltage, the cost of copper, distance, and the availability of power-plant sites with an abundance of good water near the coal supply. Some five or six years ago this question became an issue in the Chicago district. There had been talk about building a plant on the Illinois River near the coal fields, to transmit into the Chicago district, about 150 miles distant. First reports indicated a close balance between the two alternatives, but the value to the power systems of the Chicago district and the northern part of the state, of having a large, efficient station between Chicago and Springfield, led to the building of Powerton station.

The remarkable economy obtained in this station has been featured recently in these columns. One of the factors contributing to the average sustained economy is the heavy night load given this plant because of the lower coal cost, by reason of its nearness to the coal mines. Evidence substantiating the initial decision are the present and the future plans for expansion.

Against lower coal cost must be placed costs chargeable to high-tension transmission, most of which are fixed charges. What they may amount to in terms of unit output or in cost of energy to the consumer is difficult to figure, owing to variations in send-out or consumption. For Chicago, estimates have placed the fixed charges on that part of the energy flowing over the system at five to seven per cent of the cost of the energy at the power-station terminals.

Such an estimate was made by W. S. Monroe in a recent address. This comparatively small increment in cost, in his opinion, is outweighed by the reduction in the cost of power stations built away from large centers, and the stability and reliability of the supply of energy where a number of such stations are connected to a great superpower system.

As to the other factors in the premise, transmission voltage and cost of copper, the two are intimately related. As the voltage is increased, the weight of copper and the heat loss recede, considering the energy transmission constant in volume.

Taking into account more expensive insulation and wider spacing, the net results are lower transmission costs. Tendencies have been in this direction for some time. Long-distance transmission voltages of 172,000 and 220,000 may now be regarded as standard, and 330,000 volts is in the offing. This trend, coupled with the other advantages enumerated, makes possible in many cases an affirmative answer to the opening query.

Politics a Qualification

APPARENTLY the Senate intends to continue to indulge in its favorite sport of opposing the President's nominations for important positions. Recently President Hoover announced that General Edgar Jadwin, former Chief of Engineers, United States Army, would be nominated, subject to the approval of the Senate, for the chairmanship of the reorganized Federal Power Commission. Scarcely had the General's proposed nomination been made known when objection was raised against him because, while Chief of Engineers, his recommendations in connection with several projects were not popular with Senate members who are active critics of the power companies. General Jadwin by not deciding to accept the appointment probably saved himself the unpleasant experience of being the subject of Senatorial attack.

Chairmanship of the new Federal Power Commission is a difficult position. It requires one who is familiar with the intricate problems involved and who has organizing ability of the first order. The Senate's attitude toward General Jadwin's nomination will increase the difficulties of obtaining men best qualified as members of the commission. Many of those who might accept an appointment will not do so if they feel that their names are to be used to feed a political noise-machine. So long as the Senate makes political issues the qualification for high government positions the best interest of the country cannot be served.

Progress at Boulder Dam

CONSTRUCTION on Boulder Dam project on the Colorado River became active when President Hoover signed the deficiency bill containing an item of $10,666,000 to start this development and Secretary Wilbur ordered the work begun. Although development of the Colorado River has been an active question for twenty-five years, the first constructive attempt to carry out the project came in 1922, when President Harding appointed Herbert Hoover, then Secretary of the Interior, to represent the Federal Government on a commission to work out a comprehensive plan for harnessing the river. A compact was negotiated with the representatives of seven states interested and was ratified by six, Arizona refusing. This created a stalemate until December, 1928, when Congress passed the Boulder Dam Act, which authorized construction when six of the states signed the compact. Power contracts were then negotiated that would return to the government in fifty years its investment in the development. Arizona has not signed the compact and has threatened to carry her grievance to the United States Supreme Court, but so far she has not made good her threat. All the requirements of the act of 1928 have been met and preliminary work has been started.

When President Coolidge signed the Boulder Dam bill, probably not even the most stanch advocates for the development expected to see construction work started eighteen months later. Considering the many difficult problems that had to be negotiated, it speaks highly of those responsible for the settlement.

This project is the largest of its kind in the world, involving a dam over seven hundred feet high from bedrock, a storage reservoir of thirty million acre-feet capacity, and a power development of one million horsepower—all at an estimated cost of over one hundred million dollars. When the work is complete, in from from five to eight years, another great water power will have been changed from an instrument of destruction to one of service.

Chimney Data

CHIMNEYS are among the oldest equipment with which power plant engineers have had to deal. Yet little accurate data, upon which to base their design, are available. Engineers have been content to follow present practice in the design of new chimneys without securing accurate test data of chimneys now in use and analyzing such information to determine where improvements can be made.

Tests are seldom made on chimneys, although there are several which could be tested with little difficulty. Data should be made available on the drop in temperature from bottom to top of stacks of varying construction, and of infiltration through stacks.

The effect of various finishes or linings of the interior of the stack on the available draft would be worth knowing. Also the limiting velocities that can be used in chimneys, and the resultant friction losses would prove valuable information. The effect of winds should also be studied.

Chimneys form a small portion of the total cost of a plant, and this may account for the little study devoted to them by engineers. However, the total cost of all chimneys in this country is large, and small savings would soon amount to substantial totals.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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View of compressor room, showing the metered pipe joints

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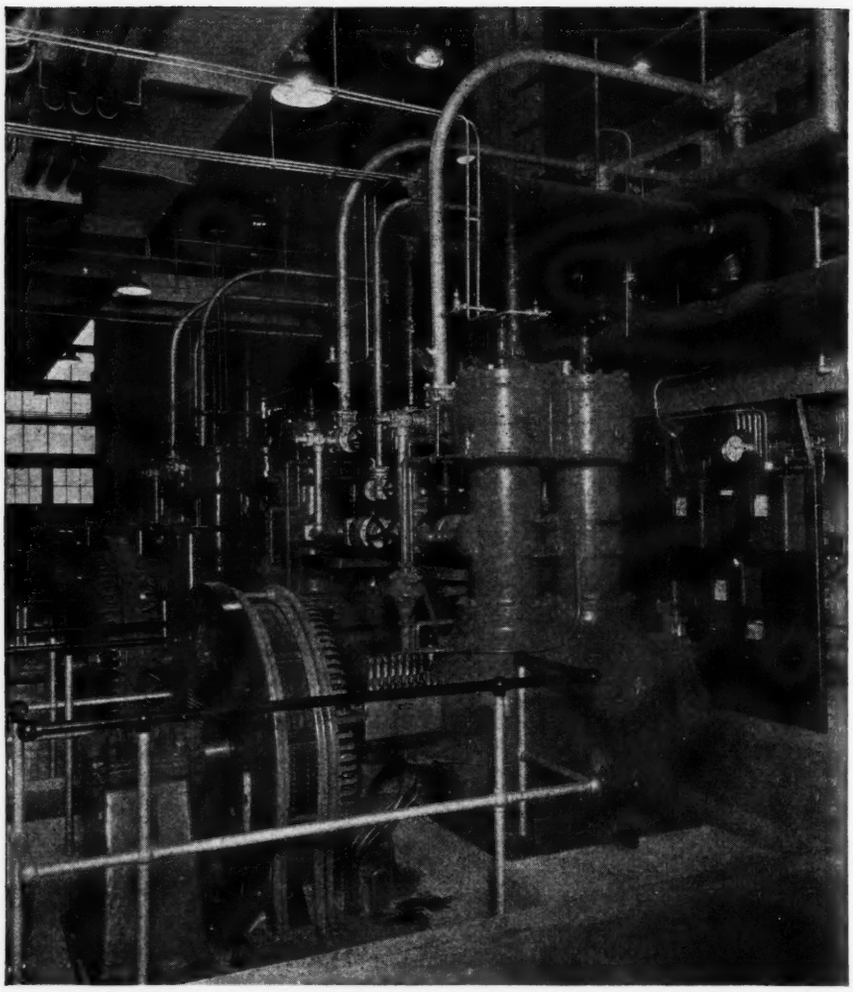


New Cold Storage Plant

OF THE TERMINAL FREEZING & HEATING COMPANY

The new cold storage plant of the Terminal Freezing & Heating Company, of Baltimore, embodies the best of modern engineering practice and contains several details that are new in refrigerating plants.

By G. S. HARRIS
Electrical Engineer
Consolidated Gas, Electric Light & Power Co.

TO IMPROVE the dependability of the district steam heating service in the central part of Baltimore and to utilize this service more fully as an adjunct to its gas and electric business, the Consolidated Gas, Electric Light & Power Company of Baltimore took over, on Aug. 1, 1928, the property and business of the Terminal Freezing & Heating Company. This acquisition included, in addition to the steam-heating property, a 75-ton ice plant and several cold storage warehouses with a total volume of approximately 1,000,000 cubic feet.

A survey of the ice plant and cold storage warehouses indicated that these properties were in no condition for resale or for continued successful operation. It was decided to minimize the ice business and to replace the cold storage warehouse by modern structures designed to meet every requirement for the proper handling and conditioning of cold storage products. A new refrigerating plant was erected on an adjacent site and was put in operation in December, 1929. The first unit of a new cold storage warehouse occupying the site of the former engine room and ice plant will be ready for service this summer.

The design of the new warehouse and refrigerating plant was undertaken after careful study and inspection of several recently constructed warehouses. The design conforms in general to the latest practice, but there are several applications not generally used in cold storage warehouses.

The present installation in the refrigerating plant in-

cludes four 85-ton compressors, two shell-and-tube brine coolers, two multi-pass condensers, and a 1,000-gal.-per-minute cooling tower. The plant is arranged for simple ammonia compression with a 3-lb. gage suction.

The brine circuit provides for an individual brine cooler and pump for each group of buildings. The brine pumps were built with bearing pedestals separate from the pump casing. This requires an initial eccentric alignment of the pump shafts, but provides a satisfactory means of preventing condensation in the bearing caps with consequent emulsion of the oil.

The brine piping and low-temperature ammonia piping were erected with welded "stove-pipe" bends instead of long-radius bends or fittings. Calculations have shown that the money saved in the pipe insulation is more than sufficient to offset the slight increase in pumping costs due to the greater friction at these bends.

All ammonia piping, designed for 300 lb. pressure, is of welded construction. The suction and discharge headers are arranged in loops, with division valves which allow the segregation of any pipe section or piece of equipment while the plant is carrying full load. A "pump out" header with connections to each subdivision of the ammonia system will prevent the escape of ammonia and facilitate maintenance.

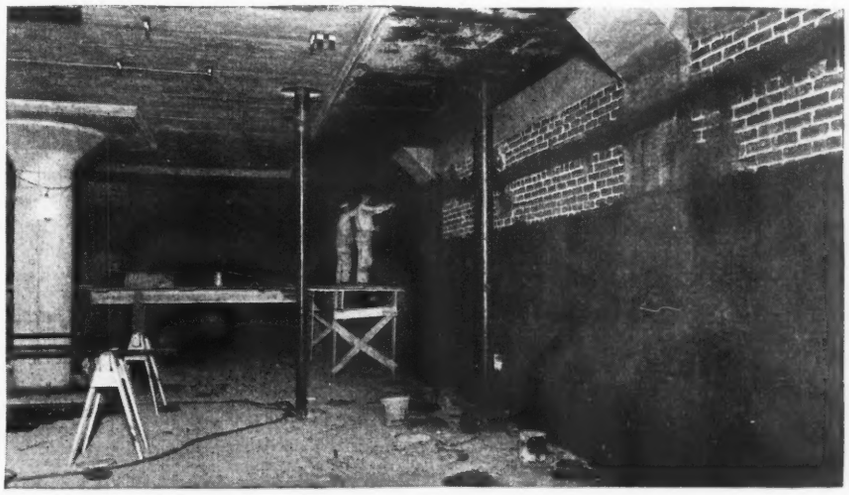
Special valves and flanges were used throughout the ammonia system. Forged-steel screwed valves were employed in sizes up to 1¼ in. The larger valves are of cast steel, with flanged ends. The flanges at the valves and equipment connections were forged with integral welding necks, and a single, deep, V-shaped groove is machined in each face. Similar grooves were provided at the valve ends. A soft steel ring fitted into the grooves, and high-tension bolts, completed the joints. This construction has a number of advantages, in that it makes a tight joint; eliminates the use of male-and-female ends, thus allowing reversal and replacement of valves; and provides a gasket material that will not deteriorate, that can be re-used, and that has sufficient resiliency to maintain a tight joint with severe temperature variations.

The first unit of the warehouse consists of an eight-story building occupying a ground area of approximately 10,000 sq.ft. and including a gross refrigerated volume of approximately 793,000 cu.ft. The first floor is about 3 ft. above the street level to facilitate unloading of trucks and railroad cars. A railroad siding is installed immediately adjacent to the east side of the building and several railroad cars can be unloaded at one time. The north end of the building is recessed to make room for automobile trucks and wagons to back into the building and up to the loading platform. The east side is arranged so that trucks can use that side when it is not needed for railroad cars. The doors are of the rolling steel type and those most frequently used are motor operated. Extension lights with automatic reels are provided at each doorway for use inside the railway cars. Platform scales are available on this floor.

In addition to the facilities for handling merchandise, there is a refrigerated receiving, or holding, room on the first floor. Merchandise that is to be stored for short periods can be placed in this room, thus relieving the elevators of that much traffic. In the event a large shipment is received, the merchandise can be unloaded from the cars and placed in this room quickly. It can then be carried up on the elevator and properly stored in the warehouse without overcrowding the elevator and at the same time providing assurance that all merchandise received at the plant will be placed in a cold storage room immediately upon its receipt.

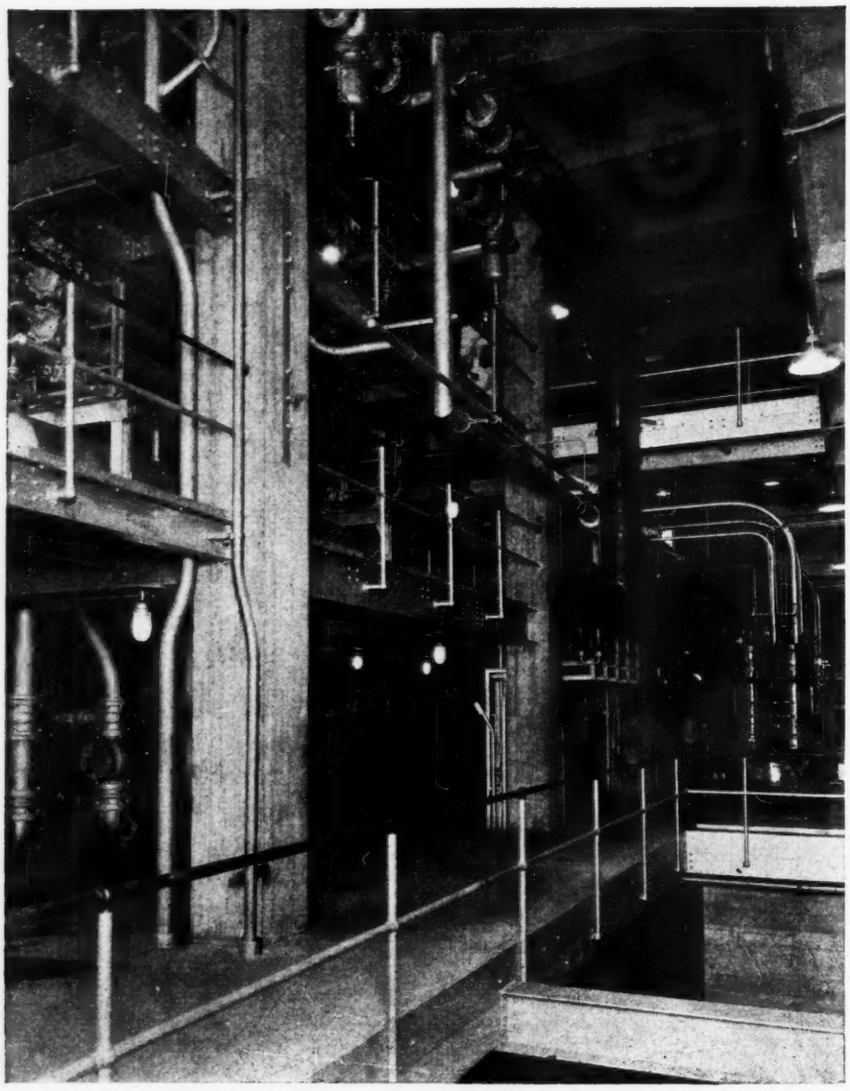
The office is in a separate building west of the cold storage warehouse and at the same level as the first floor of the warehouse, with doors giving access to the material-handling platforms. The second, third, and fourth floors are arranged for coolers designed for temperatures from 20 deg. F. upward. The sixth, seventh, and eighth floors are arranged as freezers and are designed for temperatures ranging from —10 deg. F. up. The fifth floor can be used for either purpose. Each floor is divided into one small room and two comparatively large rooms.

The building is designed in accordance with recent practice for heavy warehouse loadings and is constructed with a reinforced concrete framework of the flat-slab, mushroom-column type, with exterior walls of brick. The brick walls consist of 13-in. curtains supported by concrete spandrel beams with a brick facing over the beams and columns. The facing brick is hard-burned, with a low moisture-absorption capacity. Extensive tests were conducted to obtain a brick with a satisfactory bonding quality and the lowest possible moisture-absorption characteristics. The bricks were laid up with a weathered mortar joint, that is, the mortar is recessed at the top of the joint and slopes outward to serve as a water shed. The greatest possible care was used to insure the construction of a solid wall, with particular emphasis being placed upon workmanship. To this end it was necessary at times to have half as many inspectors as bricklayers on the job.



The brick walls were plastered with a smooth coat of Portland cement mortar conforming to screed strips placed before hand

Two elevators serve the first unit. Each has a capacity of 6,000 lb. and is operated with variable voltage contral at a maximum speed of 200 ft. per minute. Platforms are 7x16 ft. with totally inclosed cages. Wiping strips, which seal the closed cage tightly against the doors of the cold storage rooms, prevent



The condensers are placed on a gallery above the machine floor

the exchange of air between the rooms and the elevator shaft. The elevators are in the center of the building and are so arranged that one normally serves the seven rooms at the north end of the building and the other the seven large and seven small rooms at the south end of the building. Intercommunicating doors are provided on each floor for emergency use in the event one elevator is out of service.

In addition to the careful workmanship demanded in the construction of the brick walls, the interior surfaces of these walls were given two "smoothing coats" of Portland cement mortar to provide plane surfaces for the installation of the cork board. A maximum tolerance of $\frac{3}{32}$ in. was allowed in the plaster coating. The exterior columns of the building are so designed that they do not project into the cold storage rooms, thus eliminating a number of joints in the cork board and at the same time facilitating a uniform air circulation.

The cork board was applied in the usual manner, with two coats of asphaltic primer and two layers of cork board erected in hot asphalt with wooden skewers and a finish coat of asphalt emulsion troweled on. The wall surfaces and ceiling are coated with an odorless washable white paint. Each material was selected after a number of tests to determine the best. The tests included the erection and destruction of several specimen brick walls in addition to the usual laboratory and microscopic examinations.

The freezers are insulated with 7 in. of cork board on the north and east sides, and 8 in. of cork on the south and west sides. The coolers are insulated with 4 in. of cork on the north and east sides, and 5 in. on the south and west sides.

Each floor in the building is insulated with a thickness of cork board corresponding to that on the side walls. The cork board is laid in hot asphalt on the upper surface of the floor slab and is then covered with a 3-in. working surface of concrete with an integral hardener. Cork board was placed in the concrete forms as the concrete was poured, to form a ribbon of cork on the under side of each slab and prevent heat infiltration through the floor slabs. The interior columns in the cooler rooms are insulated with cork to a height of 4 ft. above the floor, and the corresponding columns in the freezer rooms are insulated to a height of 6 feet.

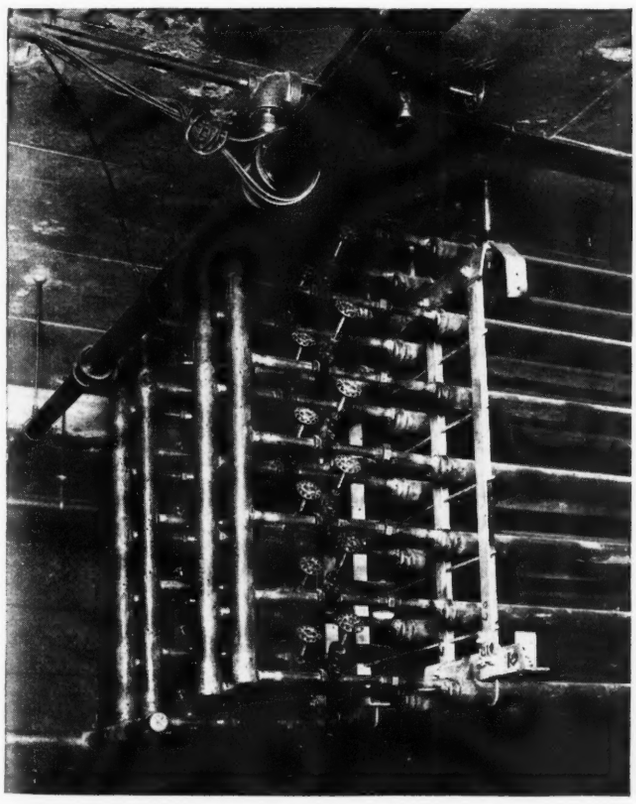
There were five major considerations in the design of the brine system. The room coils were so arranged that they would operate in conjunction with the Moore system of ventilation; the coils were designed so that small units of cooling surface could be used for the control of room temperatures; particular attention was given to the elimination of air pockets; the design and materials used in the piping were chosen to eliminate causes of galvanic action, and arrangements were made for the removal of frost in the most expeditious manner.

The Moore system of ventilation was selected because it incorporates the control of humidity within the room with a system of ventilation whereby fresh air can be admitted in any desired quantity and the gases emanating from the merchandise in storage can be removed. The ventilating appliance consists, essentially, of a central sheet-iron duct connecting with the outside air and surrounded by a cylinder of brine coils. The annular space between the outer cylinder of brine coils and the central duct is also connected to the outside. The cooling effect of the coils draws air from the outside into the annular space and discharges it at the floor of the room. Vitiated air from the upper part of the room is allowed to escape through the central sheet-iron duct, which serves as a heat exchanger by absorbing some of the heat from the incoming air. The amount of air passing through the unit is controlled by dampers. Humidity of the incoming air, and, to a certain extent, of the room, is controlled by the number of pipe sections, in the outer cylinder, in service. Additional dampers and

a motor-driven fan are provided for a moderate recirculation of air within the room or the use of outside air for refrigerating purposes.

The system also includes the arrangement of coils near the center of the room suspended from the ceiling. The aisles are invariably immediately beneath the coils. Under normal conditions the coils are the only motive power available to circulate air within the room. Cool air from the coils settles to the floor in the aisles. It is there divided and passes toward each side of the room. This air becomes heated by contact with the stored product and the exterior walls and rises toward the ceiling. The downward flow of air at the coils causes warmer air to be swept across the ceiling to the coils, and the cycle is repeated indefinitely. Tests have shown that this air circulation is continuous and that there is a complete absence of cross currents or dead spots. The system of ventilation dictated the location of the room coils.

A single-temperature brine system was selected for the new warehouse because of its economy and simplicity and also because of the more accurate control of temperature and humidity with low-temperature brine. However, to realize the full advantage of control, it is necessary either to accurately throttle the valves on the coils or to provide a coil surface which can be turned on or off in small units. The latter system was adopted, and valves are provided for individual pipe runs with an average length of approximately 120 ft. This arrangement will allow of close temperature regulation and provide a dependable method of controlling humidities. Brine flow in the coils is horizontal. A section of coil consists of a horizontal run of 2-in. pipe approximately 60 ft. long on one side of the central air port through the bank of coils and a return run of pipe at the same level on the opposite side of the central port.



Assembly at control end of brine coils. All iron valves, extra heavy seamless steel nipples and eccentric welded caps are used

Brine coolers and pumps are in the new refrigerating plant across Houser St. from Unit No. 1 of the cold storage warehouse. The brine is piped under the street in a tunnel, and after leaving the tunnel the flow is continuously upward. This means that any entrained air is allowed to travel upward through the supply risers, and, in the event it gains access to the branch feeders supplying the rooms, horizontally to the coil manifold, upward in the manifold and horizontally through the coil. After leaving the coil it rises vertically to a manifold near the roof of the building. At this point there is a connection from the top of the manifold to a balance tank on the roof and a main collector line leading back to the refrigerating plant. Entrained air escapes through the vertical connection and the balance tank, while the brine is carried downward through the collector line.

Special end connections for the 2-in. pipe are designed to completely remove the air from the horizontal room coils. The flow of brine is controlled at the inlet end of each run of pipe with a $\frac{3}{4}$-in. globe valve. A union is provided between this valve and the coil, and the nipple between the union and the 2-in. pipe is welded into a special eccentric cap stamped from $\frac{3}{16}$-in. metal. The cap fits over the end of the 2-in. coil and is welded with the $\frac{3}{4}$-in. nipple in line with the bottom of the 2-in. pipe. The outlet is fitted in a manner similar to the inlet, except that the nipple welded to the eccentric cap is in line with the top of the 2-in. pipe and a gate valve is used instead of a globe valve. Any air which finds its way through the globe valve on the feed end of the coil can rise to the top of the coil. It will then be swept horizontally through the coil and will find an easy exit through the $\frac{3}{4}$-in. pipe, which is in line with the top of this coil, and the gate valve, which will provide a full opening. By controlling the supply of brine through the globe valve and leaving the gate valve wide open, the exit for air is kept unobstructed. The coil can be drained by breaking the union on the inlet end.

The corrosive properties of calcium brine can be well controlled by promptly removing air from the system and by maintaining the correct alkalinity in the solution. Electrolysis and galvanic action are, however, separate problems. Proper grounding of all electrical equipment will probably obviate troubles from electrolysis. Galvanic action can be set up by the presence of dissimilar metals, including strained and unstrained portions in a single length of pipe. Black steel pipe with all-iron valves and pump parts was selected for this unit.

Inspection of a number of warehouses compelled to renew room coils has indicated that the great majority of coil piping becomes defective only at the threaded connections. It is believed that the threading of steel pipe not only reduces the section of metal at the threads, but also strains the remaining metal at the root of the threads and makes it electrically different from the material in the body of the pipe. To avoid this strain in the metal in the 2-in. coils, all threads in that piping were eliminated and the sections, including the special end caps, were oxy-acetylene welded. It was necessary, however, to thread the $\frac{3}{4}$-in. nipples at the coil ends to avoid an excessive cost for unions and valves. This apparent inconsistency is compensated for by the use of extra heavy seamless steel tubing, which provides an extra thick pipe wall and a soft material. The softness of the metal will tend to eliminate the strain due to threading; and, in the event the pipe is attacked at these threads,

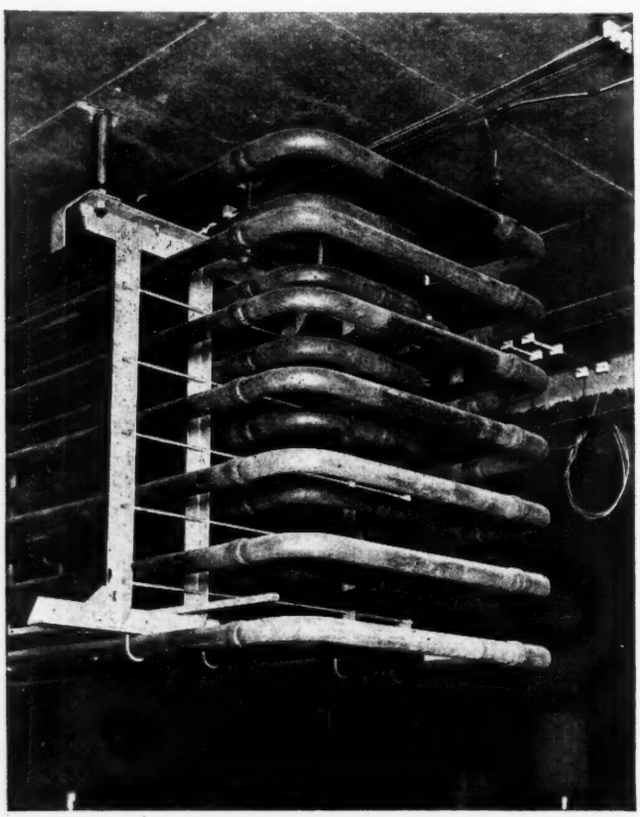
Principal New Equipment Installed

Compressors, four, twin-cylinder single-acting vertical, 12½x14½-in., 85 ton .....York Ice Machinery Corp.
Compressor motors, four 150-hp. 220-volt, 3-phase, 60-cycle, 200-r.p.m., synchronous,
(1) Electric Machinery Co.
(3) General Electric Co.
Ammonia condensers, two, 3-stand, 7-pass, multi-tube, 7 pipes high, 1,386 sq.ft. of surface.....Henry Vogt Machine Co.
Receiver, one, 24-in. x 18 ft.....Henry Vogt Machine Co.
Brine coolers, one 1,925 sq.ft. and one 246 sq.ft., shell-and-tube, Carbondale Machine Co.
Cooler control, suction trap and liquid level regulator, York Ice Machinery Corp.
Brine pumps, three, 5-in., single-stage, 700-g.p.m., 75-ft. centrifugals, direct-connected to 25-hp. Allis Chalmers Motors, Allis Chalmers Mfg. Co.
Cooling tower, one, Wheeler-Balcke, forced-draft, 1,000-g.p.m., wooden, provided with two 8-ft. propellers driven by 10-hp. Westinghouse 290/580-r.p.m. motor, to handle 100,000 cu.ft. of air per min.....Foster Wheeler Corp.
Purge drum, thermostatic type.....York Ice Machinery Corp.
Oil purifier, centrifugal type.....De Laval Separator Co.
Brine-mixing pump, 4x6-in. back-geared, piston-type, driven by 10-hp. G. E. motor.....American Steam Pump Co.
Brine-flow meters .....Bailey Meter Co.
Brine temperature recorder.....Charles Engelhard, Inc.
Ammonia pressure recorders.....Bailey Meter Co.
Ammonia liquid level indicator.....York Ice Machinery Corp.
Circulating-water flow meter.....Bailey Meter Co.
Circulating-water temperature recorder.....Wilson-Maulen Co.

the short nipples will make possible a cheap and easy replacement without necessity of disturbing the room coils.

The 2-in. lap-welded pipe used for the coils was furnished with one end belled for a "bell-and-spigot" joint with an insertion of one inch. The lengths were welded into runs in racks on the floor and were then lifted into the hangers. Return-bend fittings were eliminated by the use of three welds on pipe bends fabricated with a 9-in. belled leg and with the plain leg cut to the proper length for the coil spacing. The coils were erected so that the flow of brine will always be into the funnels formed by the belled ends.

This construction not only avoids the use of threads, but also facilitates alignment of pipe for welding, provides smoother pipes for the flow of the brine, and prevents formation of "welding shot" or "icicles" inside the pipe. To insure greater cleanliness and maximum heat transfer, the complete system was washed out with a hot solution of trisodium phosphate, which removes all particles and the oil film left in the pipes at the mills.



Pipe bends fabricated with welded bell-and-spigot joints were used instead of fittings in the room coils

Provisions have been made in each room for valved hose connections to the branch supply and return lines. It is planned to use these connections for attachment to a portable pump and an electric heater. When the coils in any room are to be defrosted, this outfit can be placed within the room and the brine in that section of coil can be circulated through the small pump and heater, thus raising its temperature sufficiently to soften the core of ice around the coil. The coil will then be defrosted by knocking the ice into a hopper mounted on a truck and moved along the aisle under the coil banks. A grating and sump are provided to sluice the removed frost into the storm sewer.

All wiring within the cold storage rooms is of the open type, with porcelain cleats mounted on wooden blocks.

The warehouse is designed with a fire tower in the northwest corner. There is a door at each floor opening from the north cold storage room to an open vestibule. A second door leads from the vestibule to the stairs, which extend from the street level to the roof. With this arrangement the smoke escaping from any room will not block the stairway or damage merchandise in the other rooms, but will be allowed to escape into the open air.

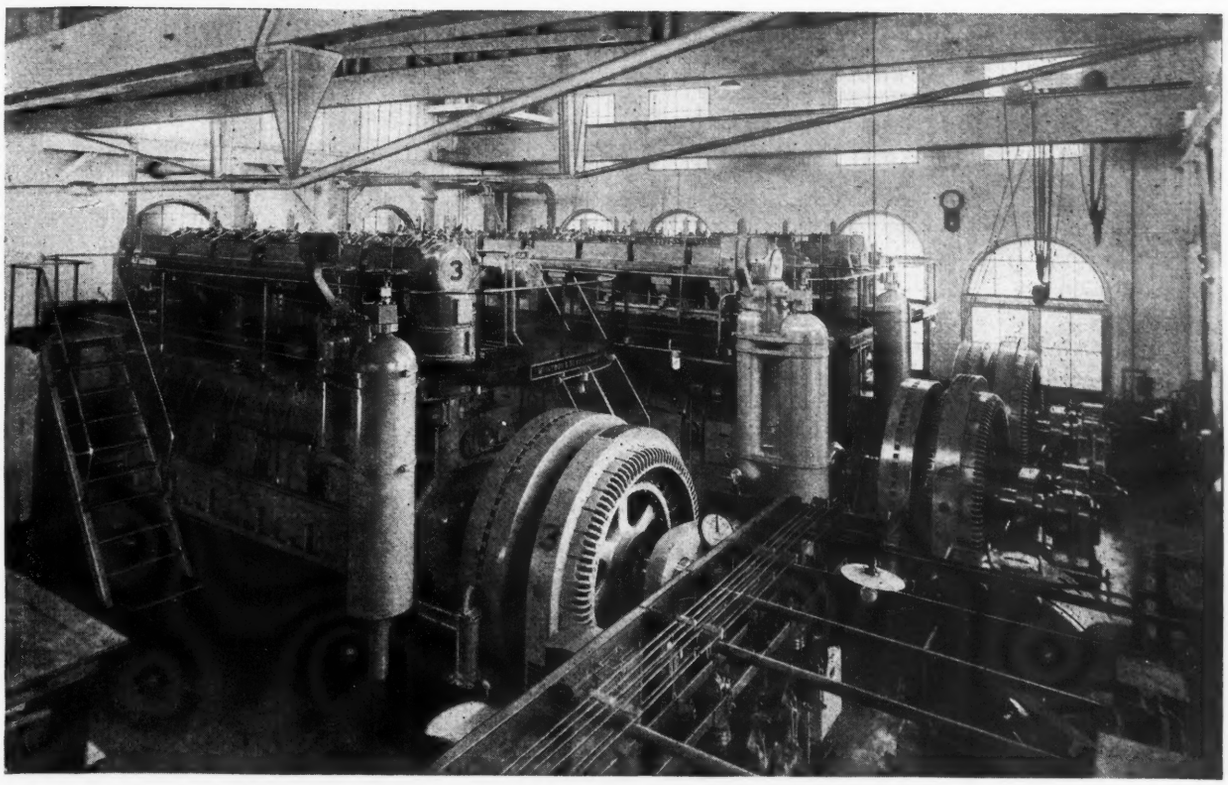
Each room is fitted with sprinklers connected to a calcium brine system. There is a 30,000-gal. storage tank above the elevator penthouse, and additional protection is offered by an emergency fire pump in the basement which can draw water from the city mains.

Explosion Risk With Ammonia

A RECENT serious accident in an ice and refrigerating plant at Syracuse, N. Y., has again demonstrated that ammonia gas and just the right proportion of air form a mixture which is highly inflammable and explosive.

The accident occurred after the bursting of a valve filled the compressor room and an adjoining boiler house with ammonia. Evidence seemed to indicate that the mixture of ammonia and air was set off by an electric spark.

Investigators considered several theories in arriving at an explanation of just how the accident occurred, but the one most amply sustained by evidence was that after the breaking of a bypass valve on one of the compressors a mixture of ammonia and air collected in the rooms and was ignited by an arc from a circuit breaker which opened automatically the instant the switch was thrown in the transformer house.—*The Locomotive.*



A Small Diesel Plant Generates Power Cheaply

In spite of its relatively small capacity, this 1,690-kw. Diesel-driven municipal light plant of Hudson, Mass., has a total power generation cost of but 1.079c. per kilowatt-hour. This includes both generation and overhead

BY LELAND D. WOOD
Manager Light & Power Department
Hudson, Mass.

UP TO JAN. 1, 1928, the Hudson (Mass.) Light and Power Department obtained most of its electric supply from a 125-lb. pressure steam station, consisting of horizontal return-tubular boilers supplying a 600-kw. and a 200-kw. turbine, but purchased some energy through a 1,000-kva. connection with a public utility. With this arrangement operating costs of the power house, excluding overhead, were 1.81c. per kilowatt-hour on the busbars. In 1927 and 1928 it was possible to buy much surplus hydro power at much less than the contract price because of excessive rainfall.

Due to the obsolete condition and insufficient capacity of the steam plant it was decided, in 1928, to determine upon a permanent method and source of electricity. The types of supply considered were: All steam-generated, part steam-generated and part purchased, purchased alone, and Diesel-engine generated. After carefully considering these types a Diesel engine station seemed to offer the most economical and satisfactory method of supply over a number of years.

The old steam equipment was completely removed, the roof over the engine room was raised to make room for a 10-ton hand-operated traveling crane, and two 900-hp., 8-cylinder, and one 675-hp., 6-cylinder, McIntosh & Seymour engines, direct connected to 615-kw. and 460-kw. G. E. generators, respectively, were installed. The engines are of the trunk piston, four-cycle, air-injection type, operating at 225 r.p.m.

The exciters are mounted on brackets on the side of the outboard bearing pedestals and are driven by a chain from the main shaft. This arrangement was chosen because of its low cost and compactness, the exciters costing only one-quarter the amount of direct-connected units, and actually taking up less space. The chains have given no trouble and show practically no wear.

The station is situated on the bank of the Assabet River, but since the water is too contaminated for direct use in cooling the engine cylinders, a closed system of

cooling was installed, utilizing town water forced by a 4-in. motor-driven circulating pump through a cooler, or heat exchanger, through the engine jackets to a 3,000-gal. cement sump in the basement. The heat exchanger is cooled by river water forced through it by a 5-in. motor-driven centrifugal pump. The heat exchanger is the old surface condenser of the 600-kw. turbine.

To guard against pump failure of any kind in the circulating water system to the cylinders a 4-in. altitude valve is so installed that should a reduction in pressure occur in the cylinder cooling water line this valve will automatically open and supply the cylinders with cooling water from the town water mains.

Fuel oil is received in tank cars, pumped into two 20,000-gal. horizontal, aboveground storage tanks, and from there to two 400-gal. service tanks in an upper corner of the engine room.

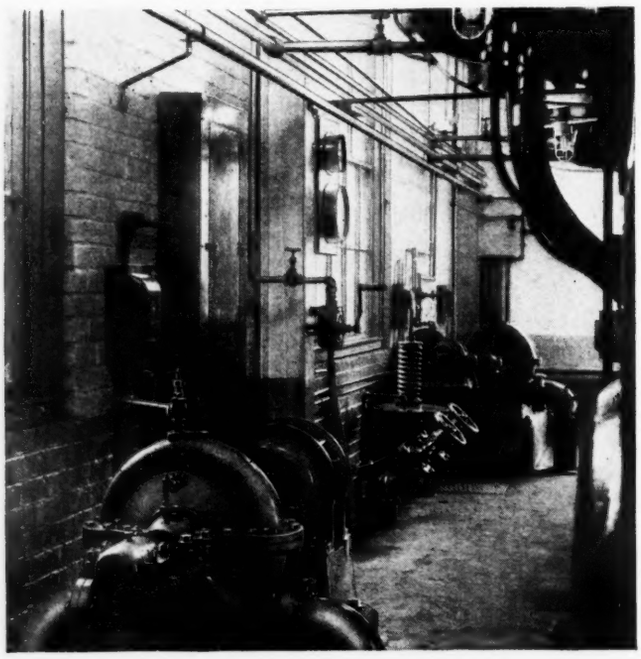
The installation costs were:

Building changes, fuel oil tanks, crane and craneway	$12,800
Pumps, piping and auxiliary equipment	4,300
Electrical work	4,700
Diesel engines, generators and exciters complete	145,200
Total	$167,000

Of which $160,000 was for plant investment and $7,000 for alterations to the existing plant.

This money was made available as follows: $127,000 from a surplus earned over a period of six years, and $40,000 from the sale of bonds bearing interest at 4¼ per cent. The depreciation allowed by the state is 3 per cent. Overhead costs are computed only on the money actually spent, 3 per cent on $160,000 for depreciation, 4¼ per cent on $40,000 for interest and $4,000 annual repayment on the bonds, making the overhead costs in the first year $10,414.98.

While the Diesel plant was being installed all power was purchased. The former steam operating force was employed in erecting the Diesel engines under the supervision of a factory engineer. In this way the steam personnel had a thorough instruction in the construction and operation of the new engines, which has proved very beneficial. The steam station employed a chief engineer, two watch engineers, a shift engineer, three firemen and a coal passer. The Diesel station has retained the same, a chief engineer, three watch operators, a shift operator, and three oilers. One fireman was promoted to operator, and the other two firemen and the coal passer were made oilers. The men work on permanent shifts or watches, of eight hours each, with one day off in seven and a two-weeks vacation with pay each year. This arrangement has worked out well.



The auxiliaries are placed along the walls

The first six months of operation from Jan. 1 to July 1, 1929, was in conjunction with purchased current, as the power contract did not expire until the latter date.

TABLE I—SUMMARY OF COSTS OF DIESEL OPERATION

Kilowatt-hours generated		3,962,900
Fuel oil used, gal.		357,678
Kerosene used, gal.		1,773
Lubricating oil used (cylinders), gal.		1,374
Lubricating oil used (bearings), gal.		1,052
Kilowatt-hours per gallon of fuel oil		11.1
Kilowatt-hours per gallon of lubricating oil		1,635
Engines run, rated hp. hr.		9,973,363
Rated hp. hrs. per gal. of lubricating oil		4,100
Expenses	**Total Amount**	**Per Kw.-hr**
Labor	$15,454.80	$.00390
Fuel oil	14,917.93	.00376
Kerosene	268.45	.00007
Lubricating oil	1,235.16	.00031
Supplies and expenses	473.00	.00012
	$32,349.34	$.00816
Overhead		
Depreciation	$4,800.00	
Bond repayments	4,000.00	
Interest on bonds	1,614.98	
	$10,414.98	$.00263
Total costs	$42,764.32	$.01079

Since then all power has been generated. Monthly operating costs are kept. A summary of the generating and overhead expenses for the year July 1, 1929, to July 1, 1930, is given in Table I.

The average B.t.u. per kilowatt-hour was 13,175, with a maximum peak of 1,400 kw.-hr. The maximum daily output was 18,400 kilowatt-hours.

When the plant was first started it used a 24- to 26-deg. Baumé gravity fuel oil having the characteristics shown in Table II.

This oil we used without heating, under all conditions of service. Last October is was found that there had been a substantial advance in prices, and, after a careful investigation, it was decided to change to a Navy A grade at a lesser price having a specific gravity of 18 to 20 deg. and with the characteristics given in Table III.

The price for six months was 3.95c., but even the present price of 4.23c. per gallon gives a substantial saving over the lighter grade.

This oil has worked excellently in the engines, there being no sign of ash. The oil is heated at the engines by bypassing a small amount of the exhaust gases through the heating chamber of the oil strainers.

TABLE II—FUEL OIL CHARACTERISTICS

	As Guaranteed	As Received
Flash, deg.	175	.....
Sulphur, per cent	1.0	.....
B. S. & W., per cent	0.75	0.59
Cold test, deg.	25	.....
Viscosity, Furol at 77 deg.	100	.....
B.t.u. per gal.	145,300	146,340
B.t.u. per pound	19,200	19,340

Price 4.6c per gal. f.o.b. Hudson.

It has been found that the injection-air pressure has to be watched more closely than with the lighter oil to avoid ignition knocks, particularly at one-half load or less.

The lubricating oil has a naphthene base, a type used extensively in engines of this manufacture. Table IV

shows the original characteristics of the oil, and the condition after a year and a half of use, with only the make-up oil added.

It can be seen that the oil is undergoing a considerable change in viscosity, and the precipitation numbers indicate that the oil has accumulated an appreciable amount of insoluble material. This oil will be thoroughly cleaned and a sufficient amount of the next lighter grade added to reduce the viscosity to nearer the original amount.

The oil is kept clean by a De Laval separator operated on the continuous filtration plan; about two pounds of carbon is removed daily.

The use of town water in a closed system for cooling the cylinders has worked out successfully. The discharge water is maintained at 130 to 135 deg. F. This temperature seems to precipitate any sediment in the 3,000-gal. sump. The water passages in the cylinders are singularly clean, being wholly free from rusty slime, and the water remains so clear that it is renewed only twice a year.

The station is situated in a locality quite free from dust and dirt. Injection air is taken from outside the building without straining, and the valves in the air compressor show practically no solid sediment. Inlet air to the cylinders is taken from the engine room.

Maintenance on the engines is light, taking into consideration the number of moving parts. Fuel inlet valves are inspected and settings checked twice a month, and they are completely taken down and cleaned three or

TABLE III—NAVY A OIL

	Guarantee	Actual
Gravity, deg. Baumé	20	20.4
Flash, deg. F.	150	170
Viscosity at 77 deg. F.	100	65.5
B. S. & W., per cent	1.0	.65
Sulphur, per cent	.9	1.29
Cold test, deg. F.	25	.....
B.t.u. per pound	18,800	18,771
B.t.u. per gallon	146,000	.....

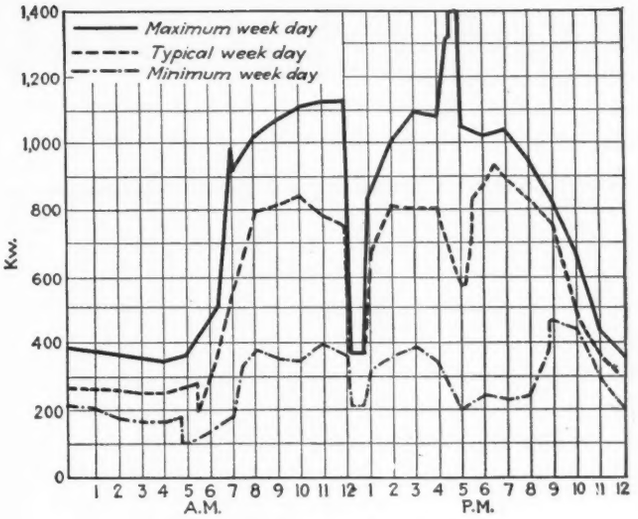
four times a year. Exhaust valves are removed after four months of operation and reground or turned. The air-inlet valves show little wear, but are inspected along with the exhaust valves. The air-compressor valves are also examined and cleaned after four months of operation and so far have shown little wear.

The pistons have been pulled once, thoroughly cleaned, and looseness in the piston-pin and crankpin bearings removed. So far little wear has been found in these bearings, an average being about 0.005 to 0.007 in. for the piston-pin boxes and none for the crankpin boxes and main bearings. With the exception of five or six, the piston rings have been found free, showing that they are being properly lubricated.

The camshafts and governors have been overhauled once since installation and were found to be running satisfactorily. The various gears are well worn in and working smoothly, so that the engines are running much more quietly than at first.

The pistons and cylinders still show the original tool marks, and are acquiring a polish which indicates indefinite life with proper lubrication. The engines as a whole are just about well broken in and are running smoothly.

While this type of engine does not actually require pyrometers in the exhaust passages from the cylinders, it was deemed wise to install them when the change was made to the Navy A fuel oil, in order to balance the work in the various cylinders. I believe pyrometers to



Daily output of the Diesel plant

be desirable on any engine and with any fuel. Previous to the installation of the pyrometers, several cases of badly pitted exhaust valves occurred, apparently due to excessive temperatures at heavy loads. After this installation the injection-air pressure was governed to keep the exhaust temperatures below 800 deg. F. at full load. As a result the valve seats have shown much less pitting.

While it is quite desirable to keep any mechanical plant as simple as possible, there are certain accessories not regularly furnished with Diesel plants that will materially help their operation economy and reduce maintenance.

In conclusion, our experience with a Diesel plant has been satisfactory. We have been able to give good service with the lowest average rates in Massachusetts, with a prospect of a further reduction soon. The engines have been as easy to maintain as a modern steam plant of equal capacity, and are simpler to operate. Our operating personnel, originally trained in steam, has become equally skilled as Diesel operators, and we believe that any good steam engineer can be an equally good, or better, Diesel operator if he really desires to. There

TABLE IV—EFFECT OF USE ON LUBRICATING OIL

	Present	New
Gravity, A. P. I., deg.	18.0	18.0
Flash, deg. F.	420	380
Fire, deg. F.	470	445
Viscosity, Saybolt Universal:		
At 100 deg. F.	1,290	750 to 780
At 210 deg. F.	74	60
Precipitation No.	0.56	.04
Carbon residue, per cent	0.88	.23
Neutralization No.	0.6	.49
Total saponification No.	4.5	4.33
Ash, per cent	0.006*	

*Chiefly iron oxide

are no mysteries about Diesels, either in their maintenance or operation. In the cases where plant managers have had trials in attempting to train steam engineers as Diesel operators the difficulty has been due to laziness, prejudice, or inability, or all three, on the part of the steam-trained employees. Such employees have no place in any station and should not be retained if they cannot adjust themselves to the new type of machinery.

There are many localities, where, because of local conditions, Diesel plants can be economically installed and operated, and our experience with such a plant is such that we can heartily commend it to anyone located where the price of oil is not excessively high or the price of coal exceedingly low.

13,800-VOLT POWER

Supplied to Chrysler Building

By H. S. ARNOLD

Supervising Engineer, Chrysler Building, New York City

The 13,800-volt feeders from the street are run up through the building to the 72d floor. Low-voltage distribution is made from banks of transformers and switchboards located at four floor levels. A total of 4,800 kw. of transformers is installed

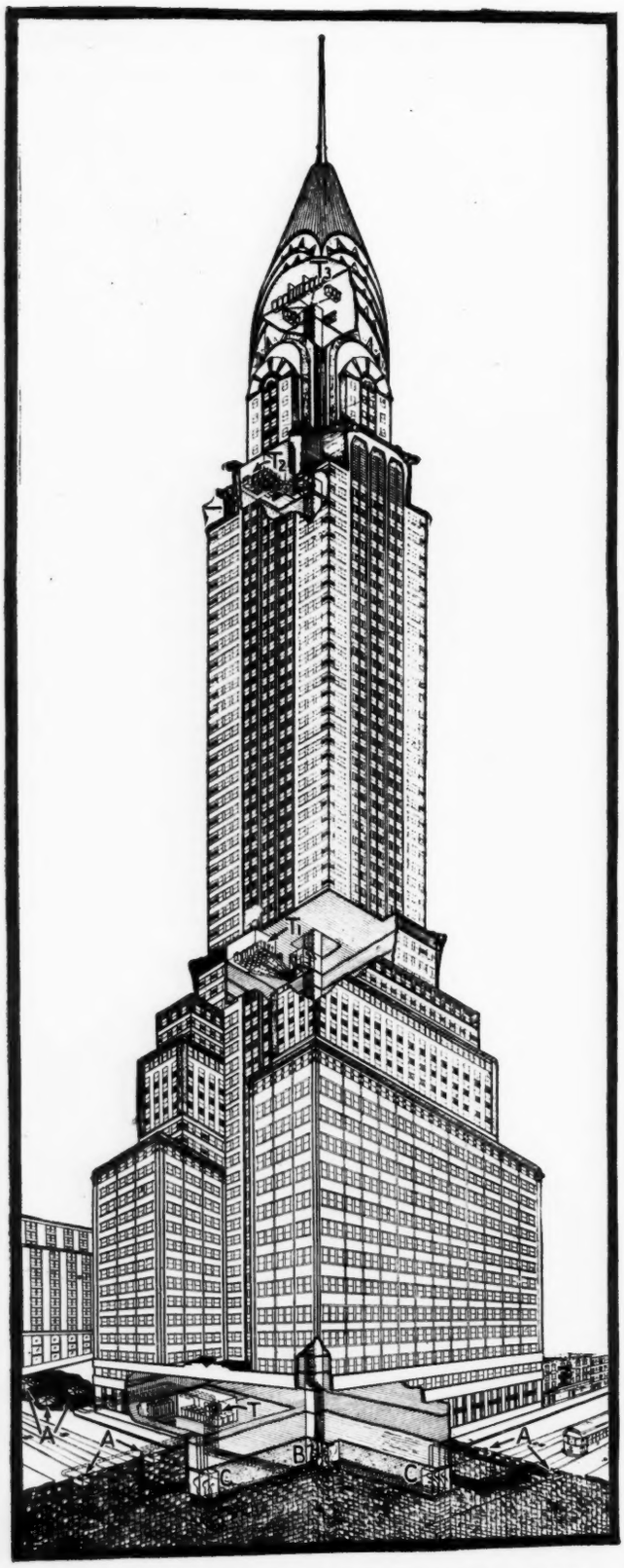


FIG. 1—CHRYSLER BUILDING, SHOWING HIGH-VOLTAGE POWER DISTRIBUTION

A indicates the location of the manholes in the street from where the power comes into the building. *B* and *C* are splicing chambers. *T*, T_1, T_2 and T_3 are transformer banks.

RECENTLY completed on the block fronting on Lexington Ave. between 42d and 43d Sts., New York City, the Chrysler Building is the highest structure in the world. It rises 1,050 ft. above the street level, has 77 stories, and is the result of the genius of W. P. Chrysler, the automobile manufacturer. In supplying power to a structure of such a great height many unusual problems confronted the engineers.

When the power distribution system was first considered a design was made for a 120- and 240-volt three-wire direct-current system. Extremely large conductors were required to carry the power to the upper floors. For some time previous to the announcement that the Chrysler Building was to be erected the writer had been studying a high-voltage feeder system, with the idea that buildings would be erected so high as to make the cost of low-voltage direct current unduly expensive. After the design of the direct-current system had been worked out the plan for a high-voltage system was brought to the attention of Frank B. Rogers, vice-president of the Chrysler Building Corporation, who gave his consent to have the details worked up. This distribution system contemplated using high-tension vertical feeders supplying banks of transformers at different levels in the building, the transformers supplying different zones into which the building was to be divided.

The proposition was discussed with the engineers of the United Electric Light & Power Company, who agreed to co-operate in working out the plan. The utility's engineers finally reported that they were prepared to install the new system and supply it from their company's 13,800-volt network system. This assured the building

owners that there would be no failure of power service, and guaranteed that there would be no interruption of elevator service, which is the heart of all high office buildings.

This system of high-tension distribution has since been adopted by seventeen other tall buildings in New York City. The new system cost about $100,000 less than direct-current distribution would have cost in the Chrysler Building. In addition to that saving, the voltage drop in the low-voltage feeders is much less than in a direct-current system, because of their shorter length. With a direct-current system some of the feeders would have been about 1,500 ft. long. Because high voltage is supplied to transformers at different levels in the building the maximum length of the low-voltage feeders is about 350 ft. and they have an average length of 200 feet.

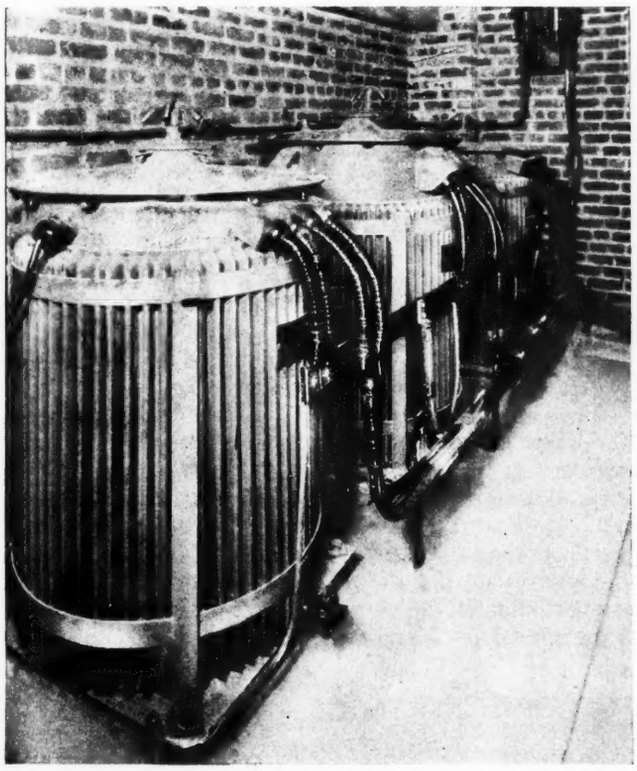


Fig. 2 (Above) — Bank of transformer on the 3,000-volt emergency power system. Normally all service will be carried on the 13,800-volt network. Should this system fail, of which there is only the remotest possibility, the most essential services will be automatically switched to the 3,000-volt transformers

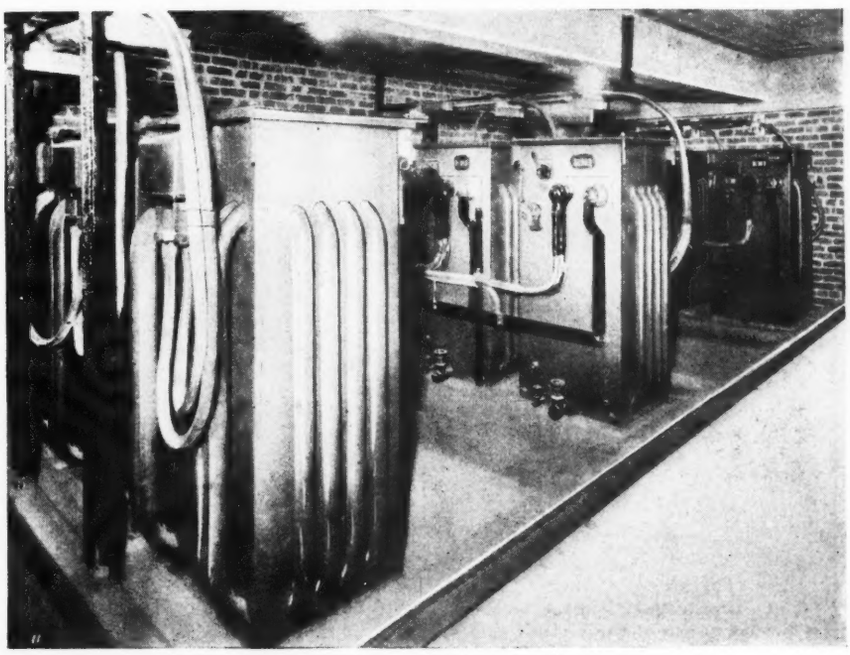
Fig. 3 (Right)—Three banks of transformer in one of the four vaults. Provision is made for a total of 13 banks of transformers on four levels

The 13,800-volt system designed by the utility company provided for five feeders from Hell Gate power house, three feeders from Waterside power house, and three feeders from East River power house, with spare feeder conduits to provide against a possible increase in the load requiring additional capacity. The service entrances are at the south side of the building on 42d St., the west side of the building on Lexington Ave. and the north side of the building on 43d St. The manholes in the streets from which the feeders come are shown at *A* in Fig. 1. Incoming feeders terminate in splicing chambers just inside of the building line on 42d St. and on Lexington Ave. At the 43d St. entrance the feeders terminate at the various banks of transformers.

From these splicing chambers single-conductor lead-covered feeders are carried to a central splicing chamber in the center of the building. The feeders from Lexington Ave. are extended up to the top of the building. Two of the feeders from 42d St. also extend to the same floor, while another feeder from 42d St. is carried through a transfer compartment over to a splicing chamber on the 43d St. side of the building. One of the feeders coming in through 42d St. passes through a transfer compartment and is carried up through the building.

At the central splicing chamber the three single conductors forming each feeder are spliced to a three-conductor, rubber-braid, steel-armored cable. These cables are carried up through 3½-in. iron conduits to a splicing chamber on the 30th floor, where a tap is made to the transformers there. The cables then are continued up to the 60th floor, and a tap made for the transformers there. From that floor the cables are continued to the 74th floor banks of transformers. All horizontal cable runs on the 30th and 60th floors are made in single conductor with rubber and lead covering.

Conduits for the vertical cables are incased in a brick-and-concrete structure which is part of the fire tower. The structure is 18 in. thick, providing 6½ in. of brick and concrete on the front, back, and sides of all vertical conduits. The vertical conduits are supported at every second floor by 4x4-in. angle irons securely fastened to the building steel, all conduits being held in place by ½-in. U bolts. On alternate floors additional angle-iron supports are securely fastened to the building steel to



support the brick-and-concrete structure around the conduits.

From the central splicing chamber in the sub-basement seven 3½-in. conduits run to the 30th floor. From the 30th to the 60th floors five 3½-in. conduits are installed, and from the 60th floor to the 74th there are four 3½-in. conduits. The conduits are placed on 9-in. centers so that they are completely surrounded with the amount of concrete at least equal to that called for by the national electrical code.

To support the vertical cables it was at first intended to break the conduit on every second floor and install a cast-iron box with a heavy cover. It was proposed to place a cable support and clamp in each box. But it was decided that the expense of this type of construction was prohibitive. A request was made for modification of the scheme and the utility company's engineers designed a new and novel cable clamp which was finally adopted. The clamp is made in three sections or plates, each plate being 8 in. in diameter and ¾ in. thick. The lower plate is provided with six drilled and tapped holes for ¾-in. set-screws. Three of the set-screws are made with an eye on the top for hooks should it be necessary to raise the cable at any time.

The electrical contractors, Hatzel & Buehler, Inc., New York City, decided to lower the cable into the conduit, which worked very successfully. How this was done and the type of cable support used will be described in a later article in *Power*.

The cables have been in position and in service for approximately 7 months, and no creeping or slipping of them or their cores have been found. In other words, the clamps are holding the cable in the same position now that they did the first day they were installed.

It was decided to locate transformers at four levels in the building, arranged so that the basement transformers T, Fig. 1, provide current for all light and power from the sub-basement to the 15th floor. A second bank T_1, on the 30th floor, takes care of the load between the 16th and 44th floors; a third bank T_2, on the 60th floor, provides for the 45th to 69th floors; and a fourth bank T_3, on the 74th floor, supplies the floodlighting and color lighting for the tower. This gives quite an even distribution of the load throughout the building.

Specially designed transformer vaults were built, the transformers being located in isolated brick compartments ventilated by air taken from the outside of the building. The network switches are outside of the transformer compartment, and lead-covered high-tension single-conductor cables are run from the splicing chambers to the transformers. From the transformers to the network switches low-voltage lead-covered conductors are installed, the network switches being located in an open space adjoining the transformer vaults. The network switches connect to a common bus located on them. Feeders from this bus run to the switchboard from which the power is distributed. In case of trouble on one bank of transformers the network switch will open and remove the faulty equipment from the system. Rubber-covered conductors are carried in rigid conduits over to the switchboards, and from the switchboards the secondary conductors, or sub-feeders, run to the various floors through the pipe shafts.

The transformer banks are connected delta on the high-voltage and star on the low-voltage to step the 13,800-volt power down to 120 and 208 volts for 4-wire, 3-phase distribution. In the present transformer arrangement there are five 300-kw. banks in the basement and on the 30th floor; four 300-kw. banks on the 60th floor; and four 150-kw. banks on the 74th floor. This makes a total of 4,800 kw. of transformer capacity.

The original design of the low-voltage feeder system for lighting was modified greatly, as it was found that segregating the different floors in accordance with their area allowed a standard size of conductor, 500,000 circ. mil., to be used, thereby permitting the contractor to purchase the cable in standard reels.

The average size of the bays throughout the building is approximately 400 sq.ft., the columns, in most cases, being placed on 20-ft. centers. Approximately 4 watts

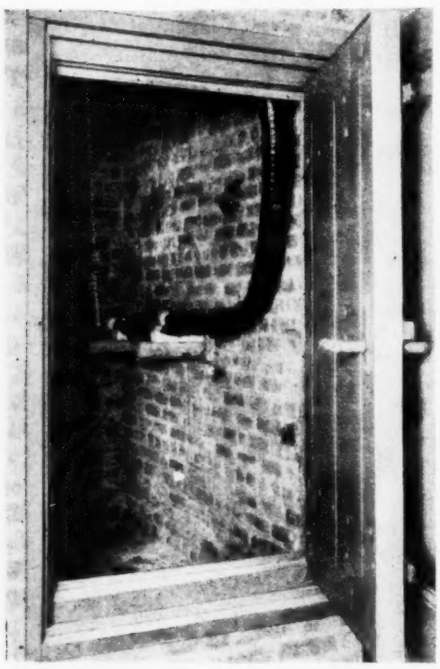


Fig. 4—High-voltage splicing chamber at the lower end of the vertical cables

Fig. 5—High-voltage splicing chamber at the top end of a cable run

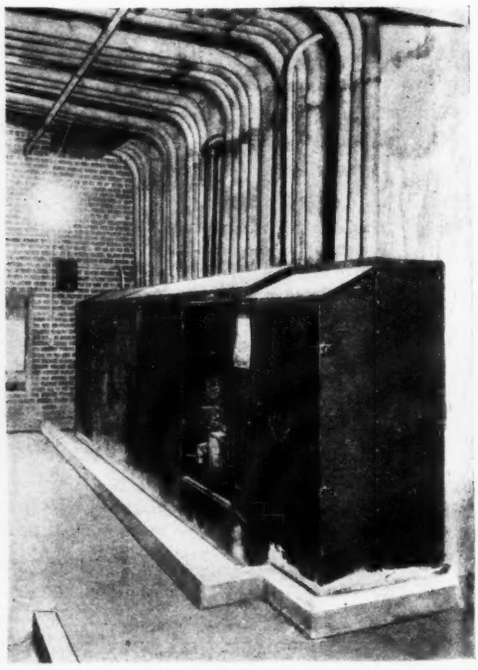


Fig. 6—Low-voltage network switches cuts out defective transformers

Fig. 7—One of the building's four low-voltage distribution switchboards

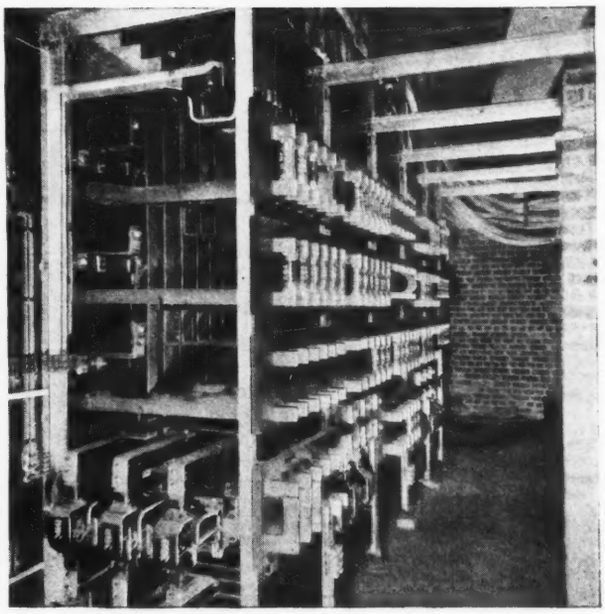


Fig. 8—The fuses are mounted on the rear of the low-voltage switchboards

per square foot was allowed for the floor areas, and the cable sizes were according to this power-consumption estimate.

The building is equipped with ceiling outlets, convenience outlets and underfloor duct systems. This arrangement made it possible to place the load on the various phases so as to give an even distribution of current in the building. For instance, if in office No. 1 phase *A* were used for ceiling outlets, phase *B* for convenience outlets and phase *C* for the underfloor system, office No. 2 would have the ceiling outlets placed on phase *B*, and so on in rotation, so that at no time would any of the phases be overloaded. Thus the system will be fairly well balanced.

The panelboards are designed to permit of metering an entire area covered by the circuit distribution, or the areas in subdivided portions may be multiple-metered. The space allotted to meter and panel rooms is somewhat larger than that usually allowed. This permits of a neat arrangement for the meters.

The underfloor duct system is designed so that the tenants may utilize the low-tension ducts for their telephone systems, either private or public; low-tension push-button call systems; and Western Union and Postal Telegraph messenger call systems. The lighting circuit underfloor duct system can be utilized for either desk lamps or motor-driven office machines. Because of the extensive underfloor duct system, convenience outlets are located on the columns only in the same outlet box with the switches. There are no convenience outlets on the walls.

On account of the architectural design it was found necessary to utilize the pipe galleries on the 30th and 60th floors for crossovers for feeders and telephone systems. At no point in the building is it possible to carry the secondary feeders or the telephone lines continuously from the lower part of the building to the upper. This is due primarily to the various setbacks and the interior arrangement of the utility spaces.

The building is protected against lightning by copper cables securely fastened to the interior steel structure at the highest possible point. Should lightning strike the structure, the discharge will be carried down through the steel of the building to the basement, from where it will be conducted into the ground by large-size cables securely fastened to the incoming water line at the water-service entrance.

The building is equipped with 30 signal-control passenger elevators. One bank of eight local cars operates at 700 ft. per minute from the ground to the twelfth floor. An express bank of eight cars runs from the first to the twenty-sixth floor. These cars operate at 700 ft. per minute, but are designed for a future speed of 800 ft. per minute. A second express bank of six cars rises from the first to the forty-fourth floor and serves from the twenty-sixth to the forty-fourth floors. These cars operate at 700 ft. per minute, but are designed for 900 ft. per minute.

A third bank of six express elevators operates from the first to the fifty-seventh floor and normally serves from the forty-fourth to the fifty-seventh floors. Two of these elevators are arranged to travel to the sixty-seventh floor, serving these additional floors, as well as all the floors through the express run for night service. This bank of elevators operate at 700 ft. per minute, but is designed for a future speed of 1,000 ft. per minute. There are two shuttle elevators operating between the fifty-seventh and seventy-first floors, and run at a speed of 700 ft. per minute.

Two service elevators have a capacity of 3,000 lb. at 700 ft. per minute. One operates from the boiler room to the twenty-third floor, and the other runs from the boiler room to the sixty-seventh floor, serving all floors. The latter can be used for safe-lifting, having a capacity of 5,000 pounds.

In addition to the elevator equipment, a load of 2,100 hp., there is an additional connected power load of about 1,900 hp. of motors, ranging in size from ½ to 300 hp., used to supply the other services to the building. The largest of these motors is rated at 300 hp. and drives the fire pump, which can deliver water from the basement to the seventy-third floor. The house and the fire pumps are installed at three levels in the building, the basement, twenty-fifth and forty-eighth floors. On the refrigerating machine there is a 125-hp. motor and the vacuum-cleaning machines are driven by two 100-hp. motors.

OXYGEN ANALYSIS IN THE BOILER ROOM

By M. E. FITZE

Test Engineer of Power Plants
Milwaukee Electric Railway & Light Company

Protection of boilers from pitting or corrosion requires, first of all, a feed-water supply free from oxygen. Deaërating equipment may lose much of its effectiveness if the thoroughness of deaëration is not constantly checked. Frequent readings of oxygen content, taken by the operators who are on hand every hour of the day, offer the most effective basis of oxygen control

AT LAKESIDE STATION of the Milwaukee Electric Railway & Light Company, oxygen analyses are made every hour of the feed-water supply for each of the three boiler rooms by the boiler feed pump operators. In addition to the two sets of apparatus in the boiler room, a set is maintained in the turbine auxiliaries room for checking the oxygen content of the turbine condensate. Throughout the plant about 100 analyses are made each day. As soon as oxygen is discovered in the feed-water supply to the boilers, it is at once followed to its source—either to the open heaters or to some one of the condensers.

Table I shows the hourly readings of oxygen content in the feed water on a typical day, and Table II the monthly averages for the entire year of 1929—evidence enough of what can be accomplished in the way of oxygen control.

APPARATUS REQUIRED

The Winkler method of oxygen analysis is used. The set-up is shown in Fig. 1, and the detail of the bottle connections in Fig. 2. The pan shown in the photograph to catch drips from the burettes is of sheet lead. Waste from the analyses is collected in the bucket. A handful or two of soda ash should be kept in the bucket to neutralize acids.

Referring to the sketch, Fig. 2, the bead valve is made by inserting a glass bead of about $\frac{3}{16}$-in. diameter in a piece of rubber tube. It is opened by grasping the rubber tube off-center at the bead, with the thumb and forefinger, and pinching. It is easy to regulate the flow, to a drop at a time, as desired.

On the starch and sodium thiosulphate bottles the pressure bulb discharge should be provided with a cotton filter, as shown in Fig. 1, to keep dust in the room from contaminating the solutions. The glass caps over the tops of the burettes keep dust from getting in at these points.

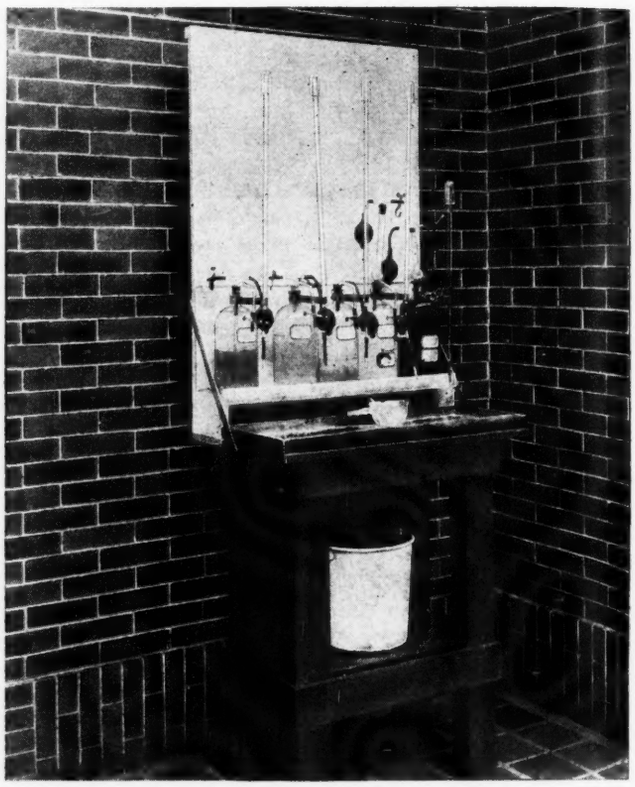


Fig. 1—Apparatus used for determining oxygen content

This arrangement of apparatus has been found by experience to be most satisfactory. It is rugged, convenient to use, and has the added advantage of portability. Individual bottles with their attached burettes may be picked up and carried to any place where the analyses can be most conveniently made. Also, for refilling, the equipment can be carried to the point where the stock solutions are kept. The apparatus can be purchased from a laboratory supply house, or the parts can be purchased separately and set up on any bottle of convenient size with a home-made clamp.

A cool sample must be used for the analyses, so the sample cooling coil shown in Fig. 3 is used. It is made by inserting a copper tube within a larger one and winding the two together on a piece of 4-in. pipe that has been chucked in a lathe with one end of the double tube held by a chuck jaw. One half of the tube is coiled on the

pipe and the other half is coiled back over the first winding. The two ends are bent to position, and the fittings brazed on as indicated. Counterflow design, coupled with high velocities, makes possible the attainment of heat transfer rates of over 2,000 B.t.u. per square foot per degree difference in temperature per hour.

An 8-oz. narrow-necked, glass-stoppered bottle is used for collecting and analyzing the sample. The amounts and strengths of chemicals are proportioned to the sample. The glass stopper is required for air tightness.

Final titration is made in the 400-cc. white porcelain casserole shown in Fig. 1. The whiteness of the porcelain gives a good background against which to detect the final "fade out" of the blue color when titrating.

COLLECTING THE SAMPLE

The sampling connection should have an $\frac{1}{8}$-in. pipe nipple about 7 in. long, or a piece of glass tubing of the same length, inserted in the end of a rubber tube of convenient length. Care should be taken to see that there is no chance for air pockets to form in the sample connections. Flush the sampling line; then close the valve until a moderate flow is obtained. Rinse the bottle with water that is to be sampled.

Quickly insert the sampling tube to the bottom of the bottle, and, after filling, allow the bottle to overflow until at least three or four bottles of water have been wasted. If air bubbles appear in the sample, it must be discarded and the cause of the bubbles corrected before another sample is taken. This is important.

After the bottle has overflowed for a sufficient length of time, slowly withdraw it from the tube, taking care to maintain a continuous overflow from the bottle. Stopper the bottle quickly but be careful that no air bubbles are trapped beneath. The small amount of water directly on the surface that has absorbed oxygen by contact with the air is discarded by insertion of the stopper.

Invert the bottle and watch for air bubbles to rise. If even the smallest bubble is present, the sample is worthless and must be discarded. If the sample is satisfactory, it should be analyzed at once.

ANALYSIS OF SAMPLE

First add 2 cc. of manganous sulphate solution and 2 cc. of alkaline potassium iodide solution. Promptly replace the stopper, being careful not to include any air bubbles, and shake well. The sample will now be cloudy.

Add 2 cc. of 1-to-1 sulphuric acid and again replace

TABLE I—HOURLY READINGS OF OXYGEN FOR TYPICAL DAY

	cc. per Liter		
Time	No. 1 Blr. Rm.	No. 2 Blr. Rm.	No. 3 Blr. Rm.
11 p.m.	0.11	0.05	0
12 mid.	0.14	0.02	0
1 a.m.	0.09	0.04	0
2 a.m.	0.07	0.07	0
3 a.m.	0.14	0.03	0
4 a.m.	0.08	0.01	0.01
5 a.m.	0.04	0	0
6 a.m.	0.07	0.02	0
7 a.m.	0.14	0.01	0
8 a.m.	0.12	0.02	0
9 a.m.	0.10	0.02	0
10 a.m.	0.09	0.01	0
11 a.m.	0.08	0.01	0
12 noon	0.09	0.02	0
1 p.m.	0.10	0.02	0
2 p.m.	0.12	0.01	0
3 p.m.	0.31	0.01	0
4 p.m.	0.25	0.02	0
5 p.m.	0.03	0.02	0
6 p.m.	0.04	0.03	0
7 p.m.	0.04	0.04	0
8 p.m.	0.30	0.02	0
9 p.m.	0.05	0.04	0
10 p.m.	0.14	....	0

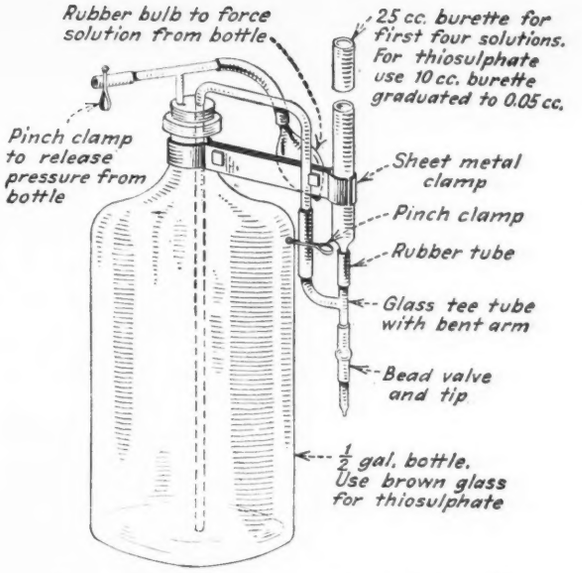

Rubber bulb to force solution from bottle
25 cc. burette for first four solutions. For thiosulphate use 10 cc. burette graduated to 0.05 cc.
Pinch clamp to release pressure from bottle
Sheet metal clamp
Pinch clamp
Rubber tube
Glass tee tube with bent arm
Bead valve and tip
½ gal. bottle. Use brown glass for thiosulphate

Fig. 2—Detail of equipment mounted on bottle

the stopper. Shake until the cloudiness has disappeared. If it does not clear up in a reasonable time, add more acid.

Pour the sample into the white porcelain casserole and set the sodium thiosulphate level to zero. If large amounts of oxygen are present the sample will be quite yellow. In this case add the thiosulphate solution while thoroughly stirring the sample with a glass rod until the yellow has nearly disappeared; then add 2 cc. of the starch solution and continue adding the thiosulphate until the blue color resulting from the starch just disappears. Calculate the amount of oxygen present from the total amount of thiosulphate used for clearing up both the yellow and the blue.

If only a small amount of oxygen is present, the yellow will be faint, if noticeable at all. In this case add the starch at once. If no blue color results from addition of the starch, oxygen is not present.

The amount of oxygen present is determined by dividing the total number of cubic centimeters of thiosulphate solution used by the constant for the particular strength solution used. The directions given later are for preparation of a solution of such strength that dividing the number of cubic centimeters used by 18 equals the cubic centimeters of oxygen per liter of sample. This strength of titrating solution has been chosen because of the ease with which calculations are made, and the high degree of accuracy that is obtainable. The amount of the weak solution required is large enough so that errors made in reading initial and final levels are negligible. After the analysis is finished, rinse out the casserole with clean water.

Especially in warm weather or when kept in a warm room, the starch solution may spoil and fail to indicate the presence of oxygen in the sample. It is well, therefore, to occasionally run through a sample into which air has purposely been admitted to see if the starch is in good condition.

PREPARATION OF SOLUTIONS

Where sufficient oxygen analysis work is done to warrant it, the first three solutions used, manganous sulphate, alkaline potassium iodide, and 1-to-1 sulphuric acid, should be made up in large lots of, say, 5 gal., and kept in

stock. The last two solutions, starch and sodium thiosulphate, should be made up frequently in smaller lots. The starch is subject to spoilage from contact with the air, and, in time, a change occurs in the normality of the thiosulphate. The thiosulphate solution should be kept in a brown bottle, as light hastens the change.

The thiosulphate solution is the only one requiring a high degree of accuracy. If an analytical balance is available, it can be made up by anyone using a reasonable degree of care. Otherwise it should be made up by an outside chemist. Chemically pure materials should be used for all the solutions.

Proportions are given for measuring out the materials by both the English and metric systems, except for the thiosulphate; so the more convenient system of weights

TABLE II—MONTHLY AVERAGE OF O2 READINGS FOR YEAR 1929

Blr. Rm. No.	1 and 2	3
January	0.02	0.01
February	0.02	0
March	0.025	0.013
April	0.06	0.017
May	0.045	0.002
June	0.03	0.003
July	0.055	0
August	0.023	0.002
September	0.03	0.006
October	0.03	0.012
November	0.05	0.014
December	0.06	0.014

can be used. As a rule, the set of weights available for the English system is not accurate enough to be used for preparing the thiosulphate solution.

Manganous Sulphate—Dissolve 480 grams of manganous sulphate and dilute to 1 liter, or 4 lb. and dilute to 1 gallon.

Alkaline Potassium Iodide—Dissolve 450 grams of sodium hydroxide and 150 grams of potassium iodide and dilute to one liter, or $3\frac{3}{4}$ lb. of sodium hydroxide and $1\frac{1}{4}$ lb. of potassium iodide and dilute to 1 gallon. A great deal of heat is generated in dissolving the sodium hydroxide, so add it to the water slowly to guard against breaking the bottle. In case of burns with the sodium hydroxide, first wash with large quantities of plain water, then rinse with vinegar.

Sulphuric Acid—Mix concentrated sulphuric acid and water in equal proportions, always being careful to add the acid to the water, never the water to the acid. A great deal of heat will be generated, so make the dilution slowly. It is well to do this in a place where no serious damage will be done if the bottle should break from the heat. Goggles should be worn to protect the eyes. In case of acid burns, first wash with large quantities of plain water, then rinse in a solution of soda ash—about $\frac{1}{2}$ lb. per gallon.

Starch—Mix a small amount of arrow-root starch with cold water to form a thin paste. Dilute the mixture to 150 to 200 times its weight of boiling water and boil a few minutes to sterilize it. After cooling, add a few drops of choroform to act as a preservative.

Sodium Thiosulphate—Making up this solution requires great care in standardization, and since it is not stable over long periods of time, the batch should be small and checked periodically to see that it is of proper strength. Only the purest of distilled water should be used. Turbine condensate containing as little as 0.1 per cent of Lake Michigan raw water as condenser leakage has been found unsuitable in preparing sodium thiosulphate solution, although it is all right for the other solutions. Condensate from extraction heaters is used, since the 0.1 per cent raw water in the condensate leaking from the water to the steam side is reduced to a negligible quantity, even though the amount of leakage is considerable. For instance, if the extraction heater leakage amounted to as much as 10 per cent, the raw water in the condensate would be only 0.01 per cent.

In the preparation of the thiosulphate, make up a strong stock solution by dissolving 70 grams of chemically pure, anhydrous sodium thiosulphate in $\frac{1}{2}$ gal. of pure distilled water. Be sure the bottle is thoroughly cleaned. Extreme accuracy in this step is not essential, as this stock solution is to be diluted down in the standardization process.

Prepare a stock solution of potassium iodate by dissolving 0.1529 grams of chemically pure, dry potassium iodate per liter of water. Use a volumetric flask to measure out the water. This is a stable solution, so it can be made up in any desired quantity and stored in a well-stoppered bottle for future use. The strength of this solution is made such that 1 cc. equals 0.1 cc. of oxygen per liter.

Prepare a stock solution of potassium iodide by dissolving 60 grams of chemically pure potassium iodide per liter of water. The weights and measures for this solution need be only approximate. The solution can be made up in any desired quantity and stored for future use.

In a clean 1-liter volumetric flask, place 20 cc. of the sodium thiosulphate stock solution, using a pipette or burette for measuring. Dilute and thoroughly mix. This is known as the sodium thiosulphate dilute solution.

Put 25 cc. of the potassium iodide solution into a clean porcelain casserole, add 1 cc. of the 1-to-1 sulphuric

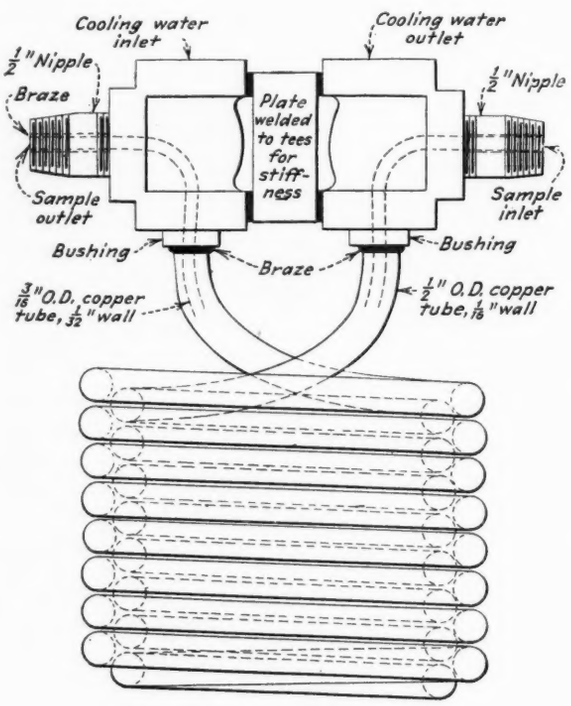


Fig. 3—Coil for cooling samples

acid, as prepared for the oxygen analysis, and to this add immediately 20 cc. of the potassium iodate solution, using a pipette or burette for accurate measurement. Stir, and add 150 cc. of water. Always add these constituents in the order stated.

Without allowing the solution to stand, add the dilute sodium thiosulphate solution from a burette until the yellow color has nearly disappeared, meanwhile stirring

with a clean glass rod. Add 2 cc. of starch solution and continue adding the sodium thiosulphate three drops at a time until the blue has entirely disappeared.

The number of cubic centimeters of the dilute sodium thiosulphate used in the foregoing titration is equal to the number of cubic centimeters of the stock solution that should be diluted to one liter in order to obtain a solution of such strength that 1 cc. equals 0.1 cc. of oxygen per liter.

The standardization procedure outlined will be necessary each time the sodium thiosulphate is to be prepared for use, until the stock solution has been found to have reached a constant strength from aging. "Threadwell's Analytical Chemistry" states that a two-months-old solution of sodium thiosulphate was standardized, and after eight months standardized again and found to be of the same strength. It will be possible therefore to finally get to a point where the solution can be prepared for use by simply diluting to predetermined proportions.

Calculations involved are as follows:

Let,

A = Cubic centimeters of stock sodium thiosulphate solution;

B = Cubic centimeters of potassium iodate solution;

C = Cubic centimeters of dilute sodium thiosulphate solution;

X = Cubic centimeters of stock sodium thiosulphate solution required for correct dilution.

Then,

$$\frac{C}{B} \times A = X$$

which for this case would be

$$\frac{C}{20} \times 20 = X, \text{ or } C = X$$

It is well to check the strength of the sodium thiosulphate solution by titrating against 20 cc. of the potassium iodate solution, as follows:

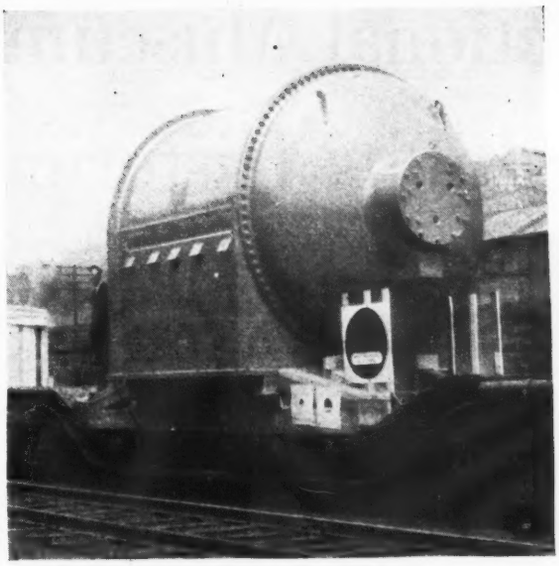
Mix the potassium iodide solution, sulphuric acid, potassium iodate solution and water in a casserole, as outlined under the standardization procedure, and titrate, using the thiosulphate solution. If the dilution has been correct, 20 cc. of the thiosulphate will be used. Agreement of less than 1 per cent should be expected. The thiosulphate solution should also be checked periodically, say every ten days to two weeks, to see that it is not changing in strength.

Changeover From Steam to Hydro Completed at Auckland

RECENTLY a celebration was held at Auckland, New Zealand, when electric power from the hydro-electric plant at Arapuni took up the full load of the city and the steam plant which had been in commission for many years was shut down permanently, unless emergency arises. The Minister for Public Works gave these figures to show the growth of the Government's expenditure in hydro-electric works:

	1925	1929
Expenditure	$19,500,000	$40,300,000
Revenue	$768,000	$2,490,000
Installed capacity, kw	22,000	144,775

Good progress is being made in stopping the water over the spillway from eroding the stream bed.



Hydrogen-filled synchronous condenser ready for shipment

A 15,000-Kva. Hydrogen-Cooled Synchronous Condenser

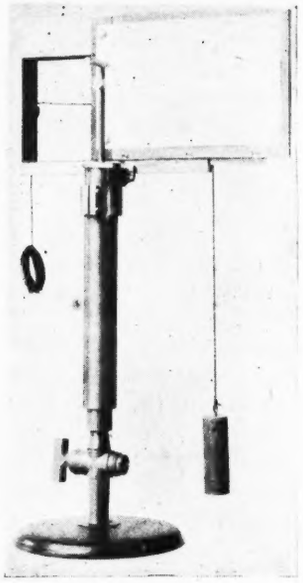
A HYDROGEN-COOLED synchronous condenser has recently been shipped to the Southern California Edison Company by the Westinghouse Electric & Manufacturing Company. This machine is rated 15,000 kva., 11,500 volts, 3 phases, 50 cycles, 750 r.p.m., and will be filled with hydrogen gas instead of air for cooling.

Many advantages have been gained by the use of hydrogen cooling instead of air cooling. The output of the machine is increased about 25 to 30 per cent above that for operation in air. The power losses are considerably lowered, this reduction showing up to great advantage at fractional loads. The damage to insulation arising from static discharge is practically eliminated. Fire hazards are reduced to a minimum, since hydrogen does not support combustion. The machine will always be clean, inasmuch as it must necessarily have a closed system of ventilation.

The condenser will be operated out of doors, and the hydrogen will be water cooled, the coolers being within the machine. Collector rings and brushes are in a small chamber at one end of the machine and can be inspected through small glass windows. When the machine is shut down, this chamber may be removed without affecting the hydrogen within the condenser.

When filling the condenser with hydrogen, an inert scavenger gas is used to expel all of the air. This operation insures against an explosive gas mixture at any time during that operation. After the condenser is filled with hydrogen, an explosion is impossible, even though there were some source of ignition. Nevertheless, the machine is made explosion proof. The pressure inside is maintained above atmospheric, so that even the negligible leakage of hydrogen will be outward. The gas is supplied from steel tanks which are provided with valves to reduce the pressure for admission into the machine. Instruments mounted on panel boards inform the operator of the pressure within, the percentage of hydrogen, and the temperature in the various parts. Numerous alarm signals are provided whereby the attendant is notified of any departure from normal conditions.

National Museum Exhibits Historic Engine Indicators



A copy of the oldest indicator, invented by James Watt

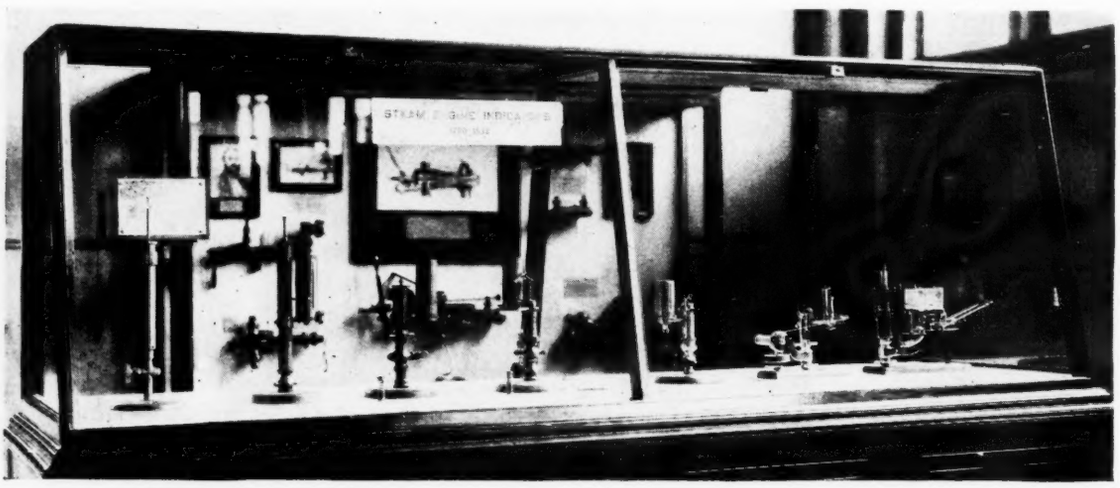
THE United States National Museum at Washington has recently rounded out an exhibition series of engine indicators that illustrate the important steps in the development of the indicator during the 150 years since its invention. There are seven indicators in the series, which includes a copy of the earliest indicator in existence as well as an example of the most recent type with an attachment for taking continuous diagrams.

The indicator is one of the many inventions credited to James Watt, who introduced it to measure the work performed by his steam engines. Watt was paid for engines on the basis of the work that they did as compared to the number of horses that they displaced, and before the invention of the indicator he had reason to complain that "the power of a horse is growing to that of an elephant."

In its first form, the indicator was a modification of the vacuum gage, consisting of a small spring-loaded piston in a cylinder which could be connected with the steam cylinder of an engine. With the slow-moving engines of early times it was possible to read the pressure at different positions of the engine piston and plot a diagram from the readings. The important addition of a pencil to the end of the piston rod of this instrument so arranged that it would mark on a sheet of paper moved by the engine is believed to have been suggested by John Southern, one of Watt's staff.

At just what date the indicator was introduced is not known. Watt found it of so much assistance to him in adjusting the valves of his engines that he kept it a secret as long as he could. The story is told that an indicator was accidentally left on an engine that was shipped to Holland from the Watt factory and that there it fell into the hands of an agent of a competitor and was thus revealed to the world.

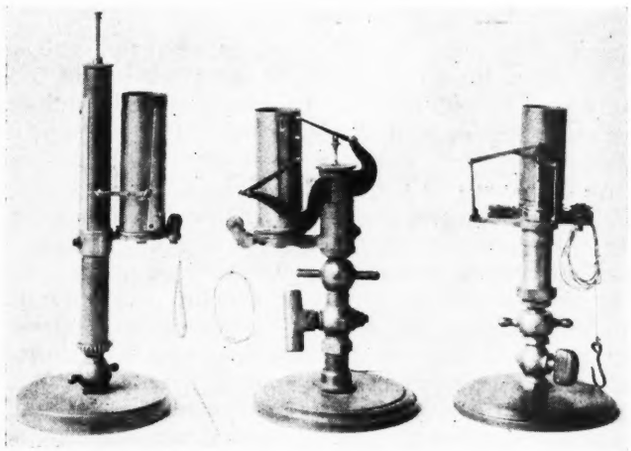
The Watt indicator in the Museum's series is a copy of an original in the Science Museum at London, that belonged to one of Boulton, Watt & Company's agents in Manchester, England. It consists of a vertical brass cylinder fitted with a piston of 1.13 in. diameter (1 sq.in. area) with a piston rod projecting from the upper end of the cylinder and carrying a pencil. Between the piston and cap at the end of the cylinder, and fastened to each, is a helical spring that is lengthened or shortened by variations in pressure below the piston and causes the height of the piston to be a measure of the pressure. The lower end of the cylinder connects with the engine cylinder and is in communication with the interior of it, so as to measure the varying pressure within the cylinder. The paper is held on a flat board which is provided with suitable fittings that permit it to slide from side to side in a frame at the upper end of the brass cylinder. The motion of the paper was effected in one direction by a cord from a point on the bridle rod of the parallel motion of the old engines, the return motion being caused by a weight and cord running over a pulley. The connection between the indicator and the cylinder was made by means of taper sockets into which the taper



The exhibit in the National Museum shows the development of indicators from 1780 to the present day

plug-cock on the lower end of the indicator fitted. Screw fittings were not necessary with the low pressures employed in the Watt engines.

The second indicator of the series is an original one made by the Novelty Iron Works, of New York, about 1835. It is No. 4 of the indicators made by them and is of the type introduced by John McNaught, of Scotland, who was the first (1825-30) to substitute a drum for carrying the paper in place of the flat board of the Watt indicator. This indicator consists of the usual cylinder, piston, and spring with a pencil attached to the piston rod by a fitting which runs in a slot in the cylinder above the piston. Supported at the side of the cylinder is the drum which carries the paper. In this instrument the drum is much like those of the standard types of the present day. It is revolved by a cord wrapped about its base, is returned by a spring within the drum, and has clips for holding the paper. The fitting which carries the pencil is hinged so that the pencil may be pressed against the paper or drawn away from it. The slot in which the pencil fitting moves has a scale engraved along its edge so that pressures within the engine cylinder can be read directly in the case of slow moving engines. The piston rod of the indicator



Some interesting types of indicators used in the past, left to right: McNaught type of about 1835, C. B. Richards indicator of the first type, and G. B. Crosby indicator of 1879

extends above the cylinder so that additional springs may be added to adapt it for use with high-pressure engines.

The third indicator of the series is an original C. B. Richards indicator of the earliest type. The Richards indicator was the first to employ a multiplying linkage between the indicator piston and pencil. In this way the travel of the piston was reduced and the distortion of the diagram through inertia of the moving parts was avoided. The Richards indicator was introduced about 1862 and may be considered the first of the modern type, as all of the instruments since introduced follow the Richards methods.

The next three indicators show some of the improvements that were effected by various inventors during the next 50 years. They include an indicator filed with the United States Patent Office by G. H. Crosby in 1879, for patent number 219,149; an original of the J. W. Thompson indicator made about 1890; and a standard inside-spring type of the present day equipped with a reducing wheel. These show various improvements in light piston designs, steam-jacketed cylinders, improved pencil linkages, and piston rod and spring fastenings.

The final indicator is a sectioned one of the latest outside-spring type equipped with an appliance invented by Prof. Gaetano Lanza for taking an uninterrupted record of the pressure changes occurring in any compression chamber or in the cylinder of any steam engine, pump, or internal-combustion engine. This device accurately feeds a continuous strip of paper in one direction at velocities proportionate to the varying velocity of the piston or pump plunger through as many consecutive strokes of the reciprocating parts as may be desired. The successive diagrams are not overlapping or deformed in any way, but each cycle is separately developed in its true proportions. This indicator and the one preceding it were presented to the Museum by the Crosby Steam Gage & Valve Company of Boston.

This series of indicators not only illustrates graphically the development of the indicator, but, by its contrast of instruments separated by relatively short intervals of time, reflects the whole rapid progress of instrument, machine, and engine design.

Thermometer Measures Losses in Hydraulic Turbines

A NOVEL, if not altogether practical, method of measuring the losses in hydraulic turbines was proposed by Prof. Dr. Ing. Foettinger of the Technical University of Berlin during a discussion of research work at the recent World Power Conference in Berlin.

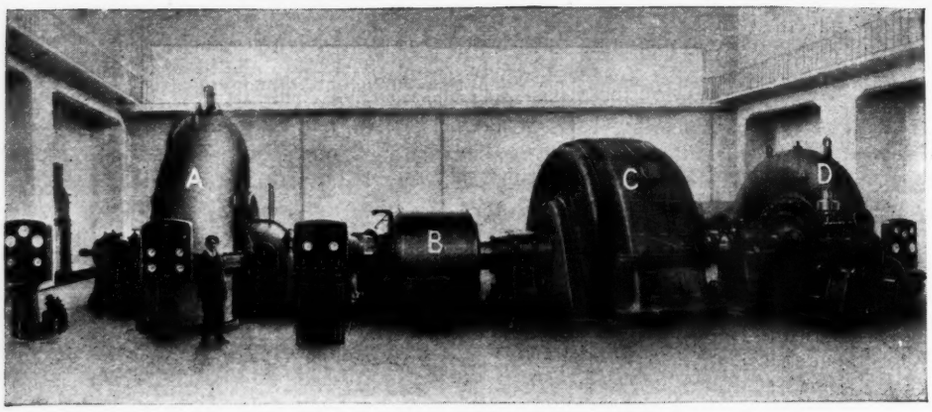
Dr. Foettinger reported investigations based upon the thesis that losses within the turbine are transformed into heat and could be segregated if means for measuring the temperature differences could be devised. The difficulty, of course, lies in the extremely small differences to be expected.

For illustration, it was pointed out that if the entire energy of the water in a case where water fell through a head of 1,400 ft. were converted into heat, the rise of temperature in the water used would be only 1.8 deg. F. Assuming, then, nominal loss of 10 per cent in the turbine, the average rise of temperature in the turbine would be 0.18 deg. F. Therefore the smaller the loss within the turbine, and the lower the net head on the turbine case, the lower would be the temperature difference resulting and the more difficult its measurement.

To investigate the possibilities of the method, Dr. Foettinger has, with the co-operation of the Siemens works, developed a thermal element which, in laboratory use, successfully indicates a temperature difference of one millionth of a degree Centigrade. With this instrument differences of temperatures have been detected, in the laboratory, with a net head as low as $\frac{1}{2}$ meter or 1.64 ft. Actual tests are at present under way in a plant having a head of 14.8 ft., of which more will be heard.

While the practical utility of this method may be questioned, it is extremely interesting, as a research project, to hydraulic engineers.

The development of the measuring instrument to record such minute temperature differences is in itself an achievement that will undoubtedly find further usefulness in heat investigations of other kinds.



Combination power and pumping unit. *A* is the pump; *B* the clutch; *C* the generator and motor; and *D* the waterwheel

WORLD'S LARGEST PUMPS DRIVEN BY 27,000-HP. MOTORS

By R. W. MILLER
Arolsen, Germany

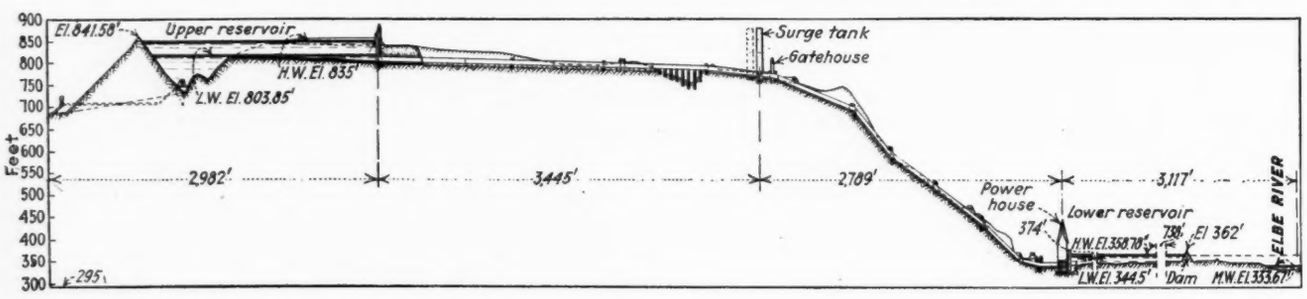
IN DECEMBER last year the Niederwartha hydro-electric plant, near Dresden, Germany, went into operation. This plant operates on pumped water and has 4 combination pumping and waterwheel units in service, but ultimately there will be eight. The pumps are the largest in operation in the world, each having a capacity of 140,000 gal. per minute against a head of 490 ft. They require 27,000 hp. to drive them. Each of the sets consists of a pump with movable diffuser vanes; an electric unit that operates either as a motor or a generator; and a 30,000-hp. waterwheel. All three units are connected on a horizontal shaft with a clutch between the pump and the electric unit. The adjustable diffuser vanes in the pumps serve to close and open their discharge during starting and in case power fails to close the discharge.

Two of the waterwheels were supplied by Voith, and two single-stage pumps on these units are of Voith-Sulzer type. The other two pumps and waterwheels are of Escher Wyss design. These pumps have a main stage and an additional wheel on the same shaft. The latter acts as a feeder to the main stage to overcome a small part of the total head. This arrangement reduces the possibility of cavitation in the high-pressure stage, as the water is supplied under pressure.

There are two storage reservoirs. A lower reservoir, forming the tailrace for the plant, is near the Elbe River, from where make-up water is supplied by low-head pumps. The surface of this reservoir when full is about 25 ft. above the river's level. It has a capacity of 67,000,000 cu.ft. with about 14-ft. draw-down. From here the water is pumped to the upper one. This reservoir is filled every 24 hr. The generators, operating as motors, drive the pumps on surplus energy during off-peak periods. The runner of the waterwheel remains coupled to the electric unit during pumping operations. In peak-load periods water from the upper reservoir operates the waterwheels and the generator supplies power to the transmission lines. In this way the system acts as a storage battery to take energy from the power lines during light-load periods and supply power when the load is heavy. When the reservoir is full it contains 67,000,000 cu.ft. of water, with a 32-ft. draw-down, sufficient to generate 560,000 kilowatt-hours.

The purpose of the Niederwartha hydraulic pumped-storage plant is to equalize load variations of the steam plants at Bohlin and at Hirschfeld that supply power to the city of Dresden. It also increases the reliability of the power system by providing a source of power that in an emergency can be put into service quickly.

Units of such large capacity cannot be started before erection in the power house. Notwithstanding this, these machines were operating at full load shortly after going into service. It might be mentioned that in the plant under construction for the Rhine-Westphalia Electric System the pumps will require 34,000 hp. to drive them.



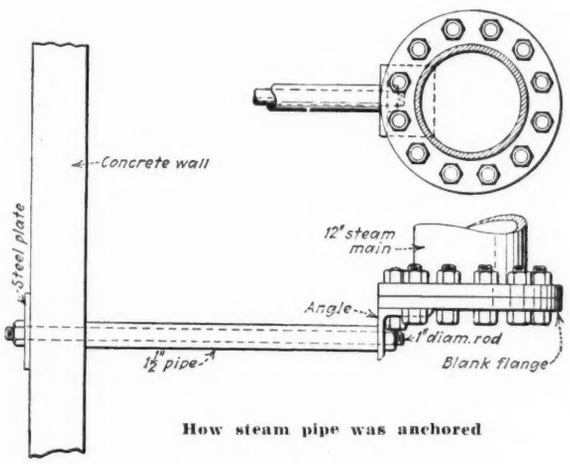
Elevation through the Niederwartha pumped-storage hydro-electric development

. . . RIGHT OUT OF THE PLANT . . .

Anchor for Vibrating Steam Pipe

AN ANCHOR was required to effectively overcome severe lateral vibration set up in a 12-in. steam main by three reciprocating engines that were connected to it. Space conditions prevented using the customary method of anchoring with rods and turnbuckles arranged to exert a pull on each side of the pipe.

A 1-in. steel rod installed through a sleeve of 1½-in. pipe was employed to tie the end of the main to an adjacent wall. The rod itself prevented lateral movement in one direction, while the pipe sleeve stopped it in the



How steam pipe was anchored

opposite direction. One end of the rod was passed through the wall and fastened by a steel plate and nut. The other end was secured to a blind flange at the end of the steam main by a piece of heavy angle iron bolted to the flange. After the anchor was held firmly in position by pulling up the nuts at the ends of the rod all vibration stopped.

T. W. BEAN.

New York City

What Recirculation Accomplishes

IN AN ARTICLE in the March 11 number entitled "What Recirculation Accomplishes" P. M. Contant goes to considerable effort to arrive at the saving in blow-off of the boilers by recirculating a considerable portion of the boiler water through the water-softening system and then returning it to the boiler, but he does not carry to a conclusion an attempted evaluation of this saving.

For the purpose of evaluating the savings and determining the cost of recirculation, I shall consider the figures he used, namely, without recirculation, the blow-off required is 5.27 per cent of the quantity of steam generated compared with recirculating 7.4 per cent with an additional 3.7 per cent blow-off to waste.

Assuming that the boilers in both cases will be equipped with continuous blow-off and heat-recovery equipment, substantially all of this heat can be returned. With a proper design of heat exchanger, the temperature differential between the boiler water wasted from the heat exchanger and the incoming make-up water would not exceed 10 deg. With 250 lb. boiler pressure, as is implied by the 3-to-1 ratio of sodium sulphate to sodium carbonate that Mr. Contant used, the heat of the liquid of 1 lb. of blow-off water would be 380 B.t.u., and with 60 deg. incoming make-up water and 10 deg. differential on the heat exchanger, the heat of the liquid going to waste at 70 deg. would be 38 B.t.u.

The heat recovered would therefore be 342 B.t.u. for each 10 B.t.u. going to waste, or a heat recovery of 97 per cent is effected. This does not mean that the loss from blowing down boilers is only equivalent to 3 per cent of the heat in the boiler blow-off, because the more important loss is that, because of heating the boiler-feed water with boiler blow-off, the amount of exhaust or low-pressure steam that can be used for heating the feed water is diminished. This, however, applies as well to the water that is recirculated through the softener as it does to the water passing to waste.

The quantity of water removed from the boiler with recirculation is 11.1 per cent of the quantity of steam generated, whereas without recirculation the blow-off is only 5.27 per cent. Recirculation, therefore, increases the amount of water removed from the boiler by 5.83 per cent of steam generated, or by an amount of 5,830 lb. per hour. This quantity of blow-off water will give off 1,214 lb. of flashed steam at atmospheric pressure for heating the boiler feed water, as illustrated by following computation:

$$\frac{5{,}830 \times (380 - 180)}{970} = 1{,}214 \text{ lb. flashed steam}$$

This flashed steam reduces the amount of exhaust or bled steam than can be used for heating the feed water. If the equivalent of this heat might be secured by bleeding the turbine at the atmospheric-pressure stage, approximately 50 kw.-hr. might be produced by 1,214 lb. of 250-lb.-pressure steam before it was used for heating feed water.

The cost of recirculating the water in this case is, therefore, the equivalent of 50 kw. of power for every 100,000 lb. of steam generated. Figuring current at 1c. per kw.-hr. this is equivalent to a charge of 50c. per hour for recirculation. If the heat is extracted from the blow-off water by a heat exchanger, substantially the only saving secured by recirculation is the saving in chemicals, which Mr. Contant says in his article is quite trifling. But again using his figures, it is equal to 6.5 lb. of soda

ash per 1,000,000 lb. of water, or 0.65 lb. for 100,000 lb. steam generated. With soda ash at 1½c. per lb., this represents a saving of 1c. for each 100,000 lb. steam generated. The saving in sodium sulphate used in his article is 21.5 lb. per 1,000,000 lb., or 2.15 lb. per 100,000 lb. steam, which at 1½c. per pound comes to 3.2c. per 100,000 lb. steam generated.

The total savings in chemicals for soda ash and sodium sulphate, is therefore, approximately 4.2c. per 100,000 lb. steam. In addition, there would be a small saving in the amount of lime, because of the hydrate radical returned to the boiler water, which Mr. Contant has not taken into account, but which if considered would probably bring the saving in chemicals up to 5c. per 100,000 lb. of steam.

Reference is also made to the recirculating system's simplifying the process of chemical treatment because by recirculation no sodium sulphate must be fed. It must be kept in mind that this only applies to the water analysis selected for the occasion, because if the water would have originally contained less than 53.5 parts per million of sodium sulphate, it would have been necessary to feed sodium sulphate with recirculation. On the other hand, if the make-up water had 75 parts per million sodium sulphate instead of 53.5, no sodium sulphate would need to be fed without recirculation, and the sodium sulphate in the boiler using recirculation would have been higher than necessary or desirable.

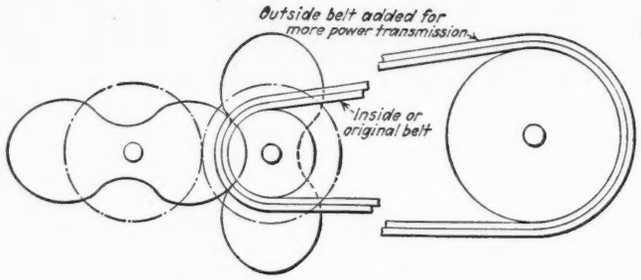
It is correctly stated in the article that increasing the excess sodium carbonate alkalinity decreases the hardness of the water, but this is true only if the proper amount of hydrate alkalinity is added to the boiler. To have a high excess sodium carbonate in the treated water does not necessarily insure a low-hardness water, because the excess sodium carbonate might all be in the bicarbonate form.

To reduce the hardness to a low degree necessitates a proper chemical treatment in addition to the excess sodium carbonate. Therefore, to obtain the low hardness of softened water specified for the recirculating system with 50 parts per million excess sodium carbonate and for a raw water containing as much as 104 parts per million temporary hardness, it is necessary that some lime be fed with the soda ash and recirculated boiler water.

If a uniform and proper chemical treatment is to be maintained where a portion of the chemicals comes from the recirculated boiler water and the remainder from a fresh supply, this materially complicates the problem, because when the chemicals are fed from two different sources two independent controls should be used.

Mr. Contant refers to the process being patented but he makes no reference to the particular details covered by patent. It would be interesting to learn specifically what features of the recirculating system are patented, because as early as 1897 Dr. M. A. Rossel, professor of chemistry of the University of Berne, before the Second International Congress of Applied Chemistry at Paris, described a method of treating boiler feed water which involved adding sodium carbonate to water in a reaction tank, filtering the softened water, and delivering it to the boilers, where the sodium bicarbonate was transformed to sodium carbonate and sodium hydrate, after which some of the excess chemicals were again returned to the softener by a continuous boiler blow-off. At that time he stated that the method was used in Switzerland since 1888, was not patented and was, therefore, open to all who desired to use it.

J. D. YODER,
Philadelphia, Pa. Cochrane Corporation.



Two belts used on a single drive

Double-Belt Drive From One Pulley

A DOUBLE-BELT drive similar to that shown in the May 27 number was used a number of years ago in a plant where I was employed. It had become necessary to install an oil-burning system, to replace natural-gas-burning equipment.

As the oil had to be burned at different places over quite a wide area, compressed air was used for atomization, and a large positive-pressure blower was installed to supply the air. This blower was supposed to be operated at a pressure of about 2 lb. above atmosphere, and it had a pulley for an 8-in. belt.

After installation the 8-in. belt furnished plenty of power for 2-lb. pressure, but the firemen complained that 2-lb. pressure was not sufficient. The pressure was raised to 3 lb., and the belt would not pull the load.

There was not room for a wider pulley, so an extra 8-in. belt was put on over the original, as shown in the illustration. This blower operated in this manner for several months on 24-hr.-a-day service.

Both belts were wire laced. I do not remember that either belt ever broke or pulled entirely apart while running. The outfit was shut down and inspected regularly, and the lacing replaced if it showed undue wear.

Coffeyville, Kan. EARL PAGETT

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THIRTY YEARS AGO, this was a common drive in isolated electric-light plants, where the usual plant contained one or more of the Thomson-Houston alternating-current generators and ring-arc constant-current machines.

At one place I saw three generators belted to one flywheel. All belts were double endless leather, the first to the wheel being 12-in., the other two 10-in. It was claimed that the second, or outer, belt suffered less wear than the one next the wheel, but the difference was small, as the creep between the two belts was slight. Anyone who has run two single belts together must have noted that one travels past the other, and if rivets are applied, will usually tear at the rivet holes; yet if left free, will function as a double belt.

In Mr. Moore's case, if his inner belt is endless he need have no fear of breakage, if properly proportioned to the load, for a well-designed leather belt will frequently give 20,000 hr. of service, and usually shows signs of wearing before the break occurs. We have fabric belts in our plants giving services at speeds which we have never been able to get a leather belt to stand, and I know of a 48-in. 8-ply rubber belt in a mill which gave ten years of service before I saw it.

Cleveland, Ohio. L. R. BAKER.

Starting 2,300-Volt Motors With Auto-Transformers

THE STATEMENT in the June 10 issue of *Power* that auto-transformers for starting motors are not particularly dangerous is, in my opinion, erroneous. I consider them one of the most dangerous pieces of electrical equipment in use today. I know of a number of cases where men have been seriously burned in explosions of auto-transformers used for starting motors of 2,300 volts and above. Death was the result in some instances.

There are several much safer methods for starting such motors, namely:

1. Have the motor designed for full-voltage starting.
2. Use series reactors to keep down the starting current. These reactors may be left in the circuit or be short-circuited by a switch after the motor is up to speed.
3. For motors above 500 hp., buy machines with two-circuit windings and arrange to connect them in series for starting and multiple for running.

It is my opinion that any one of these methods is much safer for the operator. If an auto-transformer starter is used, it should be fully inclosed in a steel or concrete housing to amply protect the operator from explosion. This practice is being followed by many companies interested in the safety of their operators. C. A. KANE.

Jersey City, N. J.

Value of a Central Station Training

A QUESTION that many young men ask upon completing a course at an engineering school is "Shall I Work in a Steam-Electric Central Station?" The following ideas on the opportunities and disadvantages may aid them in making their decisions if they are not already acquainted with central station work.

The purpose of the modern steam-electric central station is to convert fuel energy into electricity, continuously and economically. Such a plant is departmentalized into circulating water, fuel handling, boiler, turbine, electrical, machine shop, and building maintenance divisions. Young mechanical, electrical, and chemical engineers, interested in steady work have a wide and desirable choice of operating experience offered in these departments.

When a kilowatt of installed capacity costs at least $100, a 40,000-kw. or a 400,000-kw. station is rather costly and must be operated at the best efficiency to pay fixed charges and then yield a profit. The latest in plant equipment is being continually studied on an experimental or a large-scale basis. This affords the young engineer valuable practical operating experience with equipment that is larger and more advanced than the laboratory apparatus at college. The graduate should be primarily interested in practical experience. He has much to learn, and often he will find the practical work harder to master than the theory at college.

Central station experience affords wide contact with the many visiting engineers and salesmen, who often bring advanced information. These men know their particular field well and can give their wider outlook to the young engineer. It is a start for many types of later work. He may choose combustion, steam, construction, electrical operation, material handling, testing, clerical, or a sales profession.

When a young engineer understands the practical operation of a plant thoroughly, he is equipped to use the valuable experience of others expressed in the many technical journals. The proceedings of the various engineering societies become usefully available to him, since much of their records are studies in central station operation.

A study of men under good and adverse conditions is time well spent by the young engineer, since he must learn to deal intelligently with men as well as materials.

The contact between foremen and men is close in power plant operation. Continuous duty day after day in the same plant makes for that. A fireman must be closely supervised for the best use of his fuel, since there are no direct checks which can be used against him all the time to show his performance. In a large central station a fireman burns from $1,000 to $1,500 worth of fuel per shift. Thus a technical man starting as a fireman has a responsible job. With his training and the supervision of his foreman he can quickly climb as he attains practical experience. Opportunities are just as prevalent in the other departments of the central station.

Research is continually being carried on in central stations to insure the continuous, economical, and safe supply of electricity. Every central station undergoes betterment whenever possible. The manufacturers of large equipment cannot test their equipment in the shops. Often it is first assembled in the field. The operating men learn much first-hand operation with advanced equipment. High pressures, high temperatures are general with central stations, while the industrial plants are operating at lower conditions. A young engineer training now in the central station may later bring advanced ideas into the industrial power field.

Work in a central station may mean that the young engineer is "spending the first one-to-ten years in the wilderness," but he needs this foundation of practical engineering and human understanding for later work. Sundays and holidays during this time may seem just another day; shift work like prison routine; night work a martyrdom—but the price is cheap for the training that it gives the engineer. LEE G. BIRD.

Chicago, Ill.

Repairing a Drum-Head Crack

IN DISCUSSING the welding of a crack in the drum-head riveting of a water tube boiler, L. R. Baker stated in the June 17 number of *Power* that a proper repair was a crowfoot brace from head to shell opposite the crack; the crack, so he claimed, could be filled with solder or even red lead and oil, and the brace would support the load.

This should not be done, as the head has a tendency to breathe or assume a spherical shape when pressure is applied. The installation of a crowfoot brace would stiffen the head at one point so that the breathing action would be localized and would eventually start other cracks.

Either the metal in the head was damaged in fabrication or its chemical composition did not conform to the standard. I believe the safest repair would be to replace the defective head with a new one. M. C. NYE.

Stamford, Conn.

From Among Readers' Problems

Conducted by
L. H. MORRISON

NOISE IN INDUCTION MOTOR — *We have a three-phase, 60-cycle, 50-hp., 8-pole, wound-rotor induction motor that makes considerable noise when running. What may be the cause of the trouble?* A.K.

Noise in an induction motor may be from two sources, mechanical and electrical. If the bearings are worn sufficiently to allow the rotor to rub lightly on the stator it will cause noise. A bent shaft or the rotor out of balance will have the same effect, but this will cause both vibration and noise. The rotor's being loose on the shaft is a common cause of noisy operation in some of the older types of induction motors, particularly if they are operated in reversing service.

There are several electrical and magnetic causes of vibration. Two or more grounds in the rotor may cause electric and magnetic unbalance that will produce vibration. A high-resistance connection in the rotor circuit will have a similar effect. Defective or improperly connected coils in the stator winding will produce vibration and create noisy operation.

Every induction motor has a tendency to hum by reason of the magnetic vibrations set up in the teeth of the stator, especially when open slots are used. This is a feature that must be taken care of in the design of the motor. Where each phase of the stator winding is connected in two or more parallel circuits, there is a possibility of one of these circuits becoming open. This will cause the windings to be out of balance electrically and produce noise. This condition can be checked by measuring the current in each phase. Unbalanced currents in the phases, if the voltages are practically balanced, indicate that a parallel circuit may be open in the winding.

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SETTING CORLISS ENGINE SAFETY CAMS—*How should the safety cams be set on a corliss engine?* W.B.

When the cut-offs have been equalized, drop the governor to the lowest possible position, unsupported by the starting pin or collar, and set the safety cams so that the valves will not be picked up, or at least to such a position that each valve will be tripped before its lap becomes uncovered. (But it should be observed that the cams are not set so far around that the valves cannot be picked up when the governor is resting on the starting pin or collar.) Then place the governor in the very highest position, and see that the valves are not opened in that position, which is the setting to prevent the engine from racing in case of breakage of the main belt or sudden loss of load.

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PUMP SUCTION CONNECTIONS—*Why are centrifugal pumps manufactured with larger suction than discharge connection?* L.M.

To produce a flow of V feet per second there is required a pressure head h as expressed by the well-known formula $V^2 = 2gh$, where

V = Velocity in feet per sec.
h = Head in feet.
g = 32.2 (the common value of acceleration due to gravity.)

To demonstrate the desirability of making the suction larger than the discharge, take, for example, a standard 4-in. pump that has a 4-in. discharge connection and a 5-in. suction. Assuming that the pump is being used for a capacity of 700 gal. per minute, the velocity in the 5-in. suction would be 11.44 ft. per second. To generate this velocity according to the formula given a 2-ft. head is necessary. If it is now assumed that the pump is built with a 4-in. suction, the velocity will be 17.85 ft. per second, requiring a 5-ft. head. If the suction level is below the pump this lift must be supplied by the pump.

A most important reason for having larger suction when handling hot water, oils, gasoline or any other liquids that are likely to vaporize, is that there is a tendency for the liquid to vaporize, and the vaporization, of course, depends on the liquid tension of the liquid being handled. Rapid vaporization causes the pump to become vapor-bound, which results in decreased capacity or in the suction being lost completely.

Another important item is that the larger suction gives the pump a better chance to fill, due to decreased velocity, which is always important. The pump is enabled to take the water at a reasonable velocity in the suction and increase its velocity as it progresses through the impeller at a regular rise in acceleration, thereby conserving energy on the suction side.

There are examples where various velocities in suction lines are used, but the leading pump manufacturers have found that in most cases better results are obtained when the suction is made larger than the discharge.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WHAT should be a fair efficiency in a natural-gas burning boiler plant when the plant operates at 250 lb. pressure and the feed water is at 210 deg. F.? Would it pay to install economizers or air preheaters to raise the efficiency? G.C.R.

SINCE boiler efficiency depends on so many conditions, they should be stated when giving the efficiency figure. In this discussion the following values are assumed: (1) boiler output averaging 250 per cent rating; (2) stack CO_2, 10.6 per cent; (3) stack temperature, 500 deg. F.; (4) boiler setting, tight; (5) character of load, reasonably steady; (6) instruments, steam and air flow meters (hand control on fuel).

With an ordinarily skillful fireman who can avoid CO, an efficiency of 80 per cent could be expected. The heat balance would be: (1) loss due to hydrogen, 10.2 per cent (free and combined); (2) loss due to dry stack gas, 6.6 per cent; (3) radiation and miscellaneous, 3.2 per cent; (4) heat absorbed (efficiency), 80.0 per cent.

Using a 10,000-sq.ft. economizer on a 13,000-sq.ft. boiler, a stack temperature of about 250 deg. obtains, giving a unit efficiency of 85 per cent. With usual central station load conditions and average fuel prices, an annual saving of about $9,000 would result. Since

this would pay for the economizer in less than three years, the latter would be quite worthwhile. Because the boiler output would be increased some 6 per cent, the economizer is also valuable from the capacity standpoint.

The value of the air heater is less marked. Due to low excess air, gas-fired furnace temperatures are usually high when only room-temperature air is used for combustion. Draft losses are increased greatly with an air heater, and the high moisture content of the combustion products of natural gas may corrode the heater plates if the final temperature is too low. In the case of a high annual capacity factor, a large amount of radiant heat absorption area in the furnace, and clean tubes internally, the air heater might be justified. It would hardly be worthwhile for the average case, however.

Topeka, Kan. R. H. SOGARD.

PROVIDED the boiler heating surfaces are clean, the boiler plant well maintained and free from air leaks, the efficiency should be between 70 and 75 per cent.

Good efficiency is greatly dependent on the efficiency of combustion.

A feed-water temperature of 210 deg. F. seems sufficiently high to obtain good efficiency. The use of an air preheater on each boiler would certainly increase the efficiency, although how much it is impossible to say without an investigation of the plant in question. From the feed-water temperature it would appear that economizers are already in use, if the feed water is heated by external means the installation of economizers would increase the efficiency by rendering the external heating of feed water unnecessary.

W. E. WARNER.

London, England.

NOT knowing the heat value or chemical analysis of the natural gas, I shall use the average, or 1,120 B.t.u., per cubic foot. A boiler heat balance, using 250 lb. pressure and 210 deg. F. feed-water temperature and assuming 600 deg. F. steam temperature, operated at 150 per cent rating, taking an average flue gas analysis of a sample containing 11 per cent CO_2, shows about what should be expected.

The heat balance indicates the boiler efficiency to be 76 per cent without economizer or preheater. With economizer and preheater there is about an 8 per cent increase, or a total over-all efficiency of 84 per cent, which is a fair average for a modern plant. Water-cooled furnace walls would add perhaps 2 per cent to the total.

The question as to whether it would pay to gain this increase of efficiency is rather a problem in the local cost of natural gas. If the price is reasonable, I suggest that the cost of necessary equipment be weighed against the money to be saved by gaining more efficiency. Future demand and the possibility of increased plant size must also be considered. Property values may have increased in the meantime so that the additional land may be expensive. Ten boilers with economizers are worth eleven without. So I suggest that the future-demand property values and expansion program be estimated. On these the best answer to the question can be based. J.A. STACK.

New York City.

MORE DEPENDS on the skill used in firing natural gas, so far as efficiency is concerned, than on the heat-saving equipment installed; because, with natural gas, a good fireman can carry excess air as low as 10 per cent without CO if good burners are installed. Twenty per cent excess air is a fair value. By assuming a 1,000-B.t.u. gas of average composition, with stack gases at 500 deg. F., and a 4 per cent radiation loss, the B.t.u. distribution will be as follows:

	Per Cent
Heat absorbed by the water.....	76
Sensible heat in the flue gas.....	10.5
Latent heat of water in the flue gas	9.5
Radiation loss (assumed)	4.0
	100.0

So a value of 76 per cent is fair for natural gas firing. Carrying lower excess air would reduce the sensible heat loss, would not affect the latent loss, but would possibly create an incomplete combustion loss. The installation of an air preheater to raise the air to 270 deg. and lower the stack gas to 350 deg. will bring the boiler efficiency up to 79.5 per cent and effect a fuel saving of about 1c. per 1,000 lb. steam evaporated. The net saving will be less than this, because the natural-gas plant mentioned, if it is typical, operates with natural draft, and the inclusion of an air preheater will either reduce the capacity or require forced draft, with attendant operating expense. Also the higher combustion air temperature will increase the furnace temperature and may alter refractory maintenance conditions.

An economizer which will reduce the gases to 300 deg. and increase the feed-water temperature by 120 deg. will increase the boiler efficiency to 80.5 per cent and effect a saving of 4c. per 1,000 lb. evaporated. For both air preheater and economizer the fuel is taken to cost 18c. per 1,000 cu.ft. Whether these unit savings will justify the installation of the heat-saving equipment depends on the size of the boiler and the load factor at which it is being operated. Maintenance and fixed charges on this type of equipment should be taken at from 15 to 20 per cent of the first cost. FREDERICK S. MORSER,

Louisiana Polytechnic Institute.

Ruston, La.

THE boiler efficiency to be expected from natural gas fuel is not so dependent upon feed-water temperature and boiler pressure, as upon completness of combustion, proper regulation of furnace air supply, heat transfer between furnace and water in the boiler, temperatures of the air supply and the flue gas, and upon the hydrogen content of the gas fuel. Assuming that the gas in question has a heat value of 1,100 to 1,160 B.t.u. per cubic foot, a boiler efficiency of 77 per cent can be expected.

The factor of evaporation for 210-deg feed water and 250 lb. gage pressure is 1.0556; then

$$\frac{1.0556 \times \text{steam in lb.} \times 970.4}{\text{Gas in cu.ft.} \times \text{B.t.u. per cu.ft.}} = \text{efficiency in per cent.}$$

The heat loss due to water from combustion of hydrogen in natural gas is, roughly, 10 to 12 per cent, and is not recoverable in the ordinary economizer. The dry gas loss is, as with all fuels, proportionate to the amount of excess air used.

The question of economizer and air heater installation involves so many factors that advice is impossible unless more details are given. The size of the plant and steam production per 24-hr. day, cost of the fuel and of equipment, and many other items must be considered; but a saving in an economizer of approximately 1 per cent in fuel costs may be expected for each ten or eleven degrees increase in the feed-water temperature.

A. C. MCHUGH, *Chief Engineer,*
Norwalk State Hospital.

Norwalk, California.

A FAIR AVERAGE efficiency for the boiler in question is about 70 to 73 per cent, assuming that air for combustion is supplied at about 70 deg. F. and the flue gas outlet temperature is approximately 500 degrees.

It would certainly pay to install either economizers or preheaters, and probably both; the savings are dependent, of course, on the price paid for fuel.

With gas firing it may be found that the heat available in the gases at the boiler exit is greater than can be effectively used by simply passing them through an air heater. If this is so it would be practical to install an economizer and air heater in parallel, care being taken to get an even draft.

The net gain in efficiency with both economizer and air heater would be about 10 per cent, with a final flue gas temperature of approximately 300 degrees.

T. H. PARDOE.

Wolverhampton, England.

A Question for Our Readers

IS THE daily test of a safety valve by pulling it open, a good practice? Does this not cause leaking? C.F.B.

Suitable answers from readers will be paid for and published in the Sept. 2 number.

Commercial Aspects of Interchange of Power Between Utility and Industrial

By GEORGE E. WHITWELL
Vice-President in Charge of Sales, Duquesne Light Company
Pittsburgh, Pa.

This frank statement by a utility executive, presented at the recent World Power Conference in Berlin, indicates the trend toward an effective co-operation that recognizes economic fundamentals

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IN GENERAL, it is found that results and profits are to be had only when we follow the broadest economic laws that may be involved. The truth of this fundamental thought must be borne in mind continually when discussing the problem of interchanging power between utilities and large industrial plants. Here we are confronted primarily with the conservation of energy—not alone by the utility, but rather by the utility, the industrial, and any other affected interest. When either the utility or the industrial wastes heat that could be otherwise profitably utilized, we are breaking an economic law which, in the long run, will work to the disadvantage of one or both of the parties.

In years gone by, this problem of the conservation of energy (usually in the form of heat) was not as serious as it is now. Present competition, however, is daily becoming more keen. We are cutting costs in every possible place, and the days of unnecessary waste are over. It behooves the utility commercial executive to survey this problem of heat conservation and to enter into relations with industrial concerns in a way that meets with the economic laws of today—not those of yesterday.

Until only a few years ago, most commercial executives of power and light companies did not pay any attention to the possibility of interchange of power between the utility and the industrial. They felt that there was little argument but that the utility could serve the industrial more efficiently and at less cost than the industrial could serve itself—this without regard to the circumstances surrounding the industrial's operations, or without regard to the fundamental economics of the given problem.

Today, however, with modern efficiencies and other changed conditions, a more enlightened viewpoint on the part of most utility executives recognizes, with respect to a limited number of large, heat-producing or heat-using industrials, an entirely different situation. Each individual case must be studied thoroughly by the utility and by the industrial, both parties being absolutely frank—each giving the other all necessary information concerning detailed costs and other essential factors. Only in this way can it be certain that over-all maximum profit will accrue to both.

When the utility representatives meet with those of such an industrial plant in this manner, there is bound to be a frank discussion, each party having the utmost confidence in the other. Then, with the facts determined, it is a relatively simple engineering problem to ascertain the best method of interconnection for the transmission of power between the utility and the industrial. The details of how this power is to be transmitted, sometimes from one party to the other and at other times vice versa, as well as the details of plant investment, cost per unit of power, off-peak regulations, price of purchased energy and other pertinent factors, can be worked out to the satisfaction of both parties. It is only by such co-operation that we can conserve to the maximum degree the heat energy developed by both the industrial and the utility.

Interconnection As A Heat Saver

Suppose, for instance, we consider the heat and power requirements of a modern steel plant. In such an establishment there is a tremendous amount of energy available in the form of waste heat and combustible gases. Without an interconnection with a public utility or other large user of power, it is inevitable that much of this energy must go to waste and thus be absolutely of no use to the community. A good portion of this waste energy is occasioned by the non-coincidence of the heat and power requirements in the manufacturing processes. For example, during certain parts of the day the majority of the excess heat energy can be converted into electric power and used, but, during the period of the day when little electricity is being consumed, the heat energy must go to waste.

Now compare this wasting of heat when the industrial is operating alone with the efficient operation that is generally possible when the steel plant is interconnected with the utility. The utility's physical facilities, being large and flexible, can not only absorb energy from the industrial plant at such times as necessary, but at other times can reverse the process by supplying electric power to the industrial. We thus have a heat balance between the industrial and the utility which can approximate the heat balance of the most up-to-date power plant.

Interconnection as a Profit Builder

The next problem is to study the individual case, taking into account all the special circumstances surrounding it. Thus we decide whether it is feasible from a monetary viewpoint for the utility and industrial to enter into interchange of power relations.

For the interconnection to be satisfactory, it must be profitable to both parties. It would appear, upon first thought, that this can be readily ascertained. Due, however, to the many tangible as well as intangible factors involved in each case, and due also to this subject's being a comparatively new phase of the business of both utility and industrial, we find that no simple formula can be given for the solution of any particular problem. By studying in general terms the fundamental laws involved in this interchange of power, the commercial executive has a fairly comprehensive plan to follow.

A Concrete Example of Interconnection

To give a concrete example of the type of questions that arise and of the method of making an agreement be-

tween a utility and an industrial plant, we shall consider an actual case of a large steel company. The utility prepared a sixty-page report outlining in detail the problem both from the industrial plant's viewpoint and that of the utility. A few of the highlights are of interest:

1. The report concludes with the

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"When either the utility or the industrial wastes heat that could be otherwise profitably utilized, we are breaking an economic law which, in the long run, will work to the disadvantage of one or both of the parties."

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statement that the representatives of both parties consider it feasible and mutually profitable to make an interconnection of 15,000 kilowatts.

2. A $300,000 frequency changer from 25 to 60 cycles, and vice versa, so that power may be interchanged in either direction is a necessary part of the equipment to make possible the interconnection. An extension of transmission system by the utility costing $125,000 is also necessary. The annual fixed charges, figuring 13 per cent, will be $55,250 on the $425,000 capital expenditure involved.

3. There is available in the transmission system of the power company in the district under consideration capacity of 15,000 kw. at unity power factor.

4. The industrial has available spare generating capacity to act as stand-by to the utility's transmission system.

5. The utility increases its generating capacity in blocks large enough to take care of two or three years of system growth; hence, immediately after an increase in generating capacity, there

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"Each individual case must be studied thoroughly by the utility and by the industrial; both parties being absolutely frank—each giving the other all necessary information concerning detailed costs and other essential factors."

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can be available for a period of from one to three years considerable surplus energy which may be used by the industrial or others up to the time that it is absorbed by the normal growth of the utility's load. During such limited period of time the utility can sell firm power to the industrial without additional investment in generating facilities, thus permitting the industrial to delay investment in its own power plant extensions.

6. The utility's total cost of increment energy delivered at the industrial and properly safeguarded in the event of changes in the price of coal, is such that, for limited periods of one to three years, it is mutually profitable for the industrial to purchase surplus energy up to the limit of the interconnection.

7. Three general classes of service are recognized: Emergency energy, covering unforeseen requirements by either company to be supplied by the other when it has facilities available; dump energy, which will be bought from the industrial by the utility when the former has a surplus which it wishes to dispose of; surplus energy, which may be supplied by either company to the other for considerable periods under a mutual agreement made previously to the starting of such supply.

8. Thirty million kilowatt-hours per year bought by the utility as dump energy during week-end and night periods covers the cost to the industrial of interconnection fixed charges.

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"It behooves the utility commercial executive to survey this problem of heat conservation and to enter into relations with industrial concerns in a way that meets with the economic laws of today—not those of yesterday."

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The 30,000,000 kw.-hr. per year represents approximately 50 per cent load factor. The price to the utility is such that no loss is suffered by it and a profit sufficient to meet fixed charged on necessary equipment accrues to the industrial. Thus from otherwise waste heat in the industrial's plant, sufficient dump energy can be made and sold to warrant necessary capital expenditure for a frequency changer and new transmission facilities.

9. With fixed charges on capital expenditures provided for, the interconnection is made and surplus or emergency energy can be profitably exchanged.

General Aspects of Interconnection

Having reviewed a method of solving the problems connected with this industrial, let us set down some general rules that will be helpful in solving similar problems. To do this we can very profitably refer to the comprehensive paper presented at the forty-fifth annual meeting of the Association of Edison Illuminating Companies, held at the Chateau Frontenac, Quebec, Sept. 9 to 12, 1929, entitled, "Co-operative Relations Between Utilities and Industrials" and written by Messrs. Hirshfeld, Elliott, and Walker. A résumé of some of the principal points brought out in this paper are given herewith with the thought that the reader may refer to the original paper if more details are required.

Where New Types of Relations Are Most Often Called For

(*a*). Large demand for process steam at pressure consistent with power production before steam is used for process purposes—surplus or process-steam requirements or at least enough for power use—coincidence of power and process services.

(*b*). Demand for process steam less than amount required for making needed power with adequate condensing water and good load factor.

(*c*). Steam for process at high enough pressure for power generation.

(*d*). Large supply of waste heat at high enough temperature for economic steam generation.

(*e*). Large supply of combustible material as byproduct of process work, such as wood waste or combustible gas.

(*f*). Very large power requirements at good load factor in location where fuel and condensing water are available at competitive prices, so a large and economical power plant can be constructed.

(*g*). Ownership of water-power site near industrial plant.

Financial and Legal Phases:

I—Amortization of Investment:

(*a*). Utility must be able to justify expenditure on basis of both future as well as present conditions.

(*b*). Care must be taken to see that conditions do not change over a period of years. For instance, industrial may go out of business, its financial status and executive personnel may be materially altered and thus seriously affect utility's investment.

(*c*). Several ways of protecting the investment in special plant or equipment are as follows:

1. Sell plant outright to the industrial.
2. Sell plant to the industrial on the instalment plan.
3. Plant leased to the industrial but operated by the utility.
4. Plant built by the industrial and operated by the utility.
5. Special equipment installed by the utility in the industrial's plant.
6. Joint ownership of plant or equipment.

II—Factors Affecting Rates:

(*a*). Power or other service sold to the industrial.

(*b*). Power or other service sold by the industrial to the utility.

(*c*). Sale of steam to the industrial by the utility.

Revised Regulations for Pulverized Fuel Adopted by Fire Protection Association

Regulations governing pulverized fuel installations, in relation to fire protection, have been changed to conform with present practice and new designs. The changes mostly concern unit systems and driers.

AT ITS annual meeting, May 12 to 15, 1930, the National Fire Protection Association adopted the revised regulations reported by the Committee on Dust Explosion Hazards. This code contains sections pertaining to coal pneumatic cleaning plants, pulverized fuel systems, wood flour manufacturing establishments, spice grinding plants, and inert gas for fire and explosion prevention. The section on pulverized fuel systems supersedes previous regulations adopted by the National Board of Fire Underwriters, approved July 12, 1927. While the new regulations differ considerably in arrangement, but few changes have been made in the substance of the regulations and recommendations. The more important changes in the regulations are given below.

The new regulations permit the process of pulverizing fuel to be accomplished either in the room where it is burned, or in a room separated from the rest of the building by masonry walls.

Where the volumetric capacity of the mill housing, mixing, or separating chamber and all piping conveying fuel in suspension exceeds 100 cu.ft., all such piping shall be at least equal to the requirements of specification No. 2 included in the code, and all mixing and separating chambers shall either be constructed for a working pressure of 50 lb. per square inch, with a factor of safety of 4, based on the ultimate strength of the material, or located in a separate room or floor cut off from the rest of the building.

Where an inert atmosphere containing not more than 13 per cent of oxygen is maintained in an approved manner within the mills, separator, and piping, the entire milling and separating system, regardless of cubic capacity, may be located within the room or section of building where the fuel is burned. All piping conveying fuel in suspension gas shall be at least equal to the requirements of specification No. 1, and the separator, if any, shall be constructed as recommended.

Requirements for Dust Collectors

In the regulations regarding dust collectors, provision is made that cyclone separators shall meet the following minimum requirements:

1. The shell and thimble shall be made of 3/16-in. steel plate.
2. All seams shall be welded, or riveted and welded.
3. All flanges shall conform to the flanges used on connecting piping.

To the section regarding vents has been added a paragraph regarding the discharge of mill vents into the furnace. Each pipe to the furnace shall be provided with a fan. The fan and discharge pipes shall be so proportioned that the velocity in the discharge pipe from the fan is not less than 70 ft. per second. Each fan shall be provided with tight inlet and outlet dampers, arranged to open only when the flow is toward the furnace, to close automatically on interruption of flow, and to be positively held closed when the fan is not in operation.

Overheating

New regulations have been formulated to cover the recent development of coal drying in the mills. In this process heated air is injected into the air ducts where it enters the mill, and an equal quantity of moisture-laden air is removed at some point beyond the mill. The danger of fire and explosion from such a system is primarily due to overheating the coal in the mill or piping system. Such overheating may occur either when the mill is shut down or when it is in operation. This overheating can be prevented as follows:

So interlock the mechanism supplying heated air to the mill with the power supplied to the mill that heated air cannot enter the mill when it is not in operation. Dampers are seldom tight, and, if used, must be supplemented by other more positive means.

If the quantity and temperature of air supplied remain constant, with a varying coal feed or a varying moisture content coal, overheating may occur. Such overheating can be prevented by so controlling the heat supplied from the mill that a safe temperature will be maintained in the mill discharge pipe. (The safe temperature varies in different coal; under most conditions satisfactory drying and safe operation can be obtained with a discharge temperature of 90 to 125 deg. F.)

Fires occur in steam-air heaters due to the accumulation of dust on steam coils and on other parts of the heater. They shall be prevented by following precautions:

1. Keep the heater free from dust accumulation.
2. Start air flow through the heater before turning on the steam.
3. In shutting down, maintain the air flow after steam is shut off long enough to cool the heater.

With flue gas air heaters the temperature of air entering the heater is not usually controllable within narrow limits, and adjustment of air temperature entering the mill is obtained by tempering with cold air.

For the safe operation of this type of system, the following provisions shall be made:

1. Heated air must be positively prevented from entering the mill when it is not in operation.
2. Dampers, fans, and other auxiliary equipment must be so arranged and interlocked that under no conditions will an open path be provided for the flow of gas from the furnace to the pulverizer mill.

Recommendations for piping in the new regulations are divided into three specifications. Specification No. 1 follows closely the recommendations given in the 1927 regulations. For specification No. 2 a table of dimensions is given, and specification No. 3 requires 125 lb. standard full-weight steel pipe and refers to A.S.A. standard B (16a).

Arrangement of Unit Systems

Several new regulations have been added regarding the arrangement of unit systems. No pulverizers shall be connected to supply more than one furnace at a time. This does not prevent the installation of spare pulverizers, which may be connected to any of several furnaces, if the regular pulverizer is disconnected, that is, if a section of the discharge pipe between the pulverizer and the furnace is removed. Piping from mill to burner shall be so arranged that when a mill is in use all burners which that mill can supply shall be in operation. Two discharge pipes from separate mills shall not be connected to the same burner nozzle.

The regulations contain two appendices, one relating to the storage of coal, which includes a table giving the maximum time for storing pulverized or dried crushed coal at various temperatures. The other appendix con-

tains recommended procedure for extinguishing fires in pulverized coal conveyors, pipes, ducts, collectors, and bins.

The difficulty in extinguishing pulverized coal fires is recognized by all who have had any experience in connection with the operation or maintenance of pulverized fuel plants. Fires which otherwise would have been of slight extent have spread beyond the incipient stage as a result of the application of improper extinguishing methods.

Fire-Fighting Procedure

For the purposes of general information and guidance to those who may be called upon to aid or direct such fire-extinguishing operations, the regulations give the following procedure:

In case fire is discovered in pulverized fuel conveyors, pipes, ducts, or collectors:

1. Stop coal supply as quickly as possible.
2. Stop air supply as quickly as possible.
3. Close all vents and gates and inspect all vents and gates which should close automatically.
4. Introduce steam, carbon dioxide or other inert gas. It is suggested that pipe connections be provided on all such equipment for the ready introduction of the extinguishing medium. Such connections should not be less than one inch.
5. If fire extinguisher cannot be applied or is ineffective, water may be introduced. Care should be taken not to use a high-pressure stream that would create dust clouds and perhaps cause an explosion. Water should be used only under supervision of responsible authorities.
6. Procedure after fire is out will depend entirely on local conditions. In general, the equipment should not be put into operation until it has been thoroughly cleaned.

In case fire occurs in a pulverized fuel bin:

1. Stop coal supply to bin.
2. Stop carrier air to bin.
3. Close bin vent damper, or if it is automatic make sure it is tight.
4. Make sure that all other openings into bin, other than feeders, are tight.
5. Notify foreman and firemen.
6. Foreman should determine whether fire has been caught quickly enough to be snuffed out by its own fumes.
7. If necessary, introduce steam or inert gas. It is suggested that 1 in. or 2 in. pipe connection or a small handhole be provided in the top of bin for this purpose.
8. If the fire has made considerable headway before being discovered, and the vent damper has been damaged or seams have opened, it is imperative that every effort be made to close these openings with water-soaked bags or similar material. If the material used is combustible it should be kept wet.
9. The use of large quantities of water inside the bin should be avoided, because it is of practically no value in putting out a fire in large quantities of pulverized fuel, and because it makes it almost impossible to use the feeders.
10. The bin should be emptied as quickly as possible, even while the fire is in progress, by feeding coal to the furnace. This should be done in spite of difficulties with feeders due to lumps of coke.
11. If all coal can not be fed to the furnace through feeders, the fire should be completely extinguished before the bin is opened.
12. After the fire is out and the bin is opened as much coal as possible should be scraped from the side walls with rods manipulated through the manhole on top of the bunker. If coke jams the feeders an attempt should be made to break it up with rods. If this fails workmen must enter the bin.
13. Before workmen enter the bin it shall be thoroughly aired for several hours to eliminate fumes and to test whether fire is really out. The bin should then be entered only on authority of responsible persons, and the men shall wear oxygen breathing apparatus and have ropes around their waists held by others outside the bin. The men in the bin shall be watched continuously unless the fire has been out and the bin opened for at least 24 hours.

Routine Inspection Essential

Practically all fires can be extinguished and coal can be fed through the feeders without these emergency measures, unless there has been negligence in routine bin inspection. Routine inspection should consist in opening the bin once a day. A man putting his head within the manhole can determine whether there is any unusual increase in bin temperature or in fumes from smoldering fire, and if he temporarily turns out his light he may be able to notice a dull red glow. Such inspections of course, should not be made while bin is being filled, nor until dust is settled after a filling period.

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Valves, Pipe, Welding, Fatigue Discussed at A.S.T.M. Meeting

MEETINGS of the American Society for Testing Materials, an organization that is essentially a group of working committees, are notable for variety of subjects covered in detail. At the recent annual meeting in Atlantic City (June 24-27) several of the reports and papers contained material of interest to manufacturers and users in the power field.

For example, in high-test gray-iron castings, the transverse test load was changed from 2,250 to 2,500 lb., and the tensile breaking strength from 28,000 to 33,000 lb. per square inch. Specifications for castings for valves and fittings were advanced to standard over strong protests from Southern producers, who claimed that the 0.75 per cent phosphorous limit discriminates against their iron.

It was reported that work is under way on quality specifications for welded, riveted, and lock-bar pipe. Simultaneously, a sectional committee of the American Standards Association is at work on dimensional standards for pipe, which may be completed next year.

A study of the suitability of standard steel for fusion welding, by a sub-committee of the steel committee, resulted in the finding that satisfactory fusion welding by the regular commercial processes is feasible with steel of the following A.S.T.M. grades: Bridge, building, locomotive and car, ship, boiler and firebox, forge-welding plate, boiler tube, welded and seamless pipe, cold-drawn wire reinforcement.

Fatigue tests of fillet arc welds, reported by R. E. Peterson and C. H. Jennings (Westinghouse Electric & Manufacturing Company), were made on rotating specimens 2 in. in diameter in the middle part, with end sections of 1 in. diameter welded on by ring-shaped fillet welds of $\frac{1}{4}$- to $\frac{3}{4}$-in. size. Endurance limits of 15,000 to 20,000 lb. per square inch, calculated on the 1-in. cross-section of the end pieces, were found. Welds smaller than 0.30 in. broke in the welds; larger ones on the 1-in. shaft.

Heat-treated chromium-molybdenum aluminum steel had an endurance limit of 76,000 lb. per square inch, according to tests made by N. L. Mochel of the Westinghouse Electric & Manufacturing Company. He found that nitriding raised the limit to 84,000.

Dr. D. J. McAdam, of the United States Navy engineering experiment station, found that the initial rate of net damage in corrosion, combined with cyclic stress, varies as the third or fourth power of the stress. The accelerating influence of cyclic stress on corrosion is attributed partly to disturbance of the protective surfaces, and partly to increase of solution pressure by cold working.

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New orders for 1,280 steel boilers were placed in May, as reported to the Department of Commerce, by most of the leading firms in the industry, compared with 1,017 boilers in April and 1,751 in May, 1929. May sales of mechanical stokers totaled 96 with 31,956 hp., compared with 108 of 35,903 hp. in April and 174 of 60,772 hp. in May, 1929.

WHAT'S NEW IN PLANT EQUIPMENT

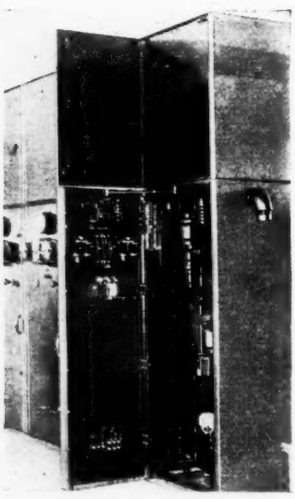
HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

New Indoor Cubicle

A NEW LINE of indoor cubicle-type switching equipment consisting of oil breakers and vertical swinging panels, with disconnecting switch compartments, is announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

These units are for either manual-, alternating-current- or direct-current-solenoid-operated oil circuit breakers, and may be equipped with automatic reclosing equipment, if electrically operated, which will reclose the circuit breaker a definite number of times on a predetermined schedule.

The cubicles are constructed of structural steel members and one-eighth inch thick open-hearth steel shapes securely welded together to form a rigid structure unit. The lower section of the cubicles is divided into two compartments between which is a vertical steel barrier which completely separates the high-tension equipment from the breaker mechanism and secondary control wiring, thus assuring safety to attendants or maintenance men.



Steel indoor cubicle with panels

The oil circuit-breaker compartment is closed by a hinged steel door which permits of inspection of the equipment and removal of the breaker tanks. Cubicles up to and including 42-in. widths have single hinged doors, while those of greater width have double doors hinged at each side.

A New Metal for Chains

A NEW LINE of cast chains designated "Promal," which is said to show remarkable strength and durability in comparison with malleable chains, has been introduced by the Link-Belt Company, Chicago, Ill.

Experimentation with cast-chain metals led to the discovery of a new method of processing malleable iron which so altered its physical characteristics as to make it a new metal. Compared with malleable iron and annealed mild cast steel the characteristics are as given in the accompanying table.

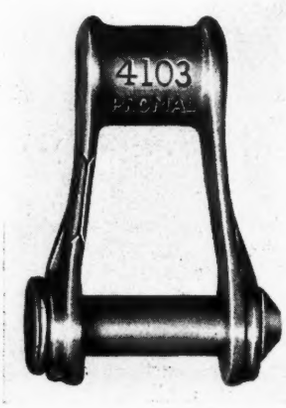
PROMAL COMPARED WITH MALLEABLE IRON AND CAST STEEL

	Average Yield Point, Lb.	Average Ultimate Strength, Lb.	Average Elongation, Per Cent	Brinell Hardness
Promal	45,000	65,000	14	170–190
Malleable iron	36,000	54,000	18	110–130
Mild cast steel, annealed	34,000	60,000	26	120–140

It is apparent that the new metal has the qualities desirable in sprocket-chain material; great toughness to resist extreme tension without permanent stretch; high strength in proportion to weight and size; and hardness that affords great resistance to abrasive wear.

Owing to higher Brinell hardness, the new chains withstand abrasive wear better than the usual cast chain. A yield point or elastic limit 25 per cent higher than that of average malleable iron will be recognized by engineers as of greater importance than ultimate strength. In addition to having a high yield, the metal is tough and ductile, so that it withstands shock and fatigue loads. High temperature reduces its tensile properties somewhat, but temperatures up to 1,000 deg. F. will not cause it to become brittle.

Promal chains are recommended particularly for four general classes of service: chain drives, elevators and conveyors operating under gritty or abrasive conditions; chain drives where greater strength is required than the corresponding size of malleable-iron chain provides; drag, scraper, and flight conveyors where the chain drags and is subject to abrasion; heavy-duty drives of comparatively high speed, short centers and large sprocket ratios.

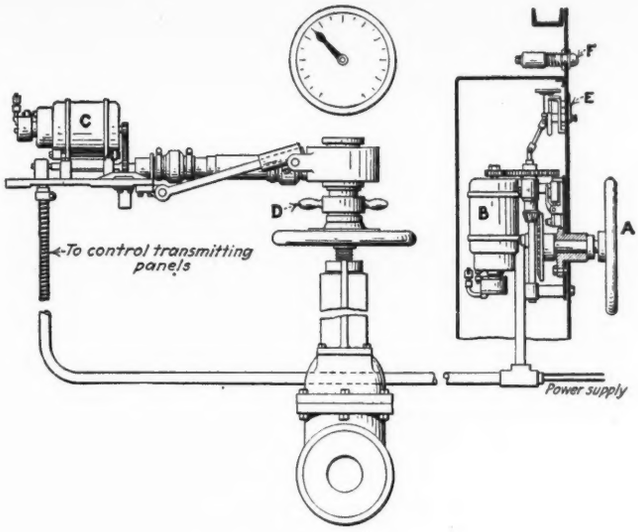


Typical Promal chain link

System of Remote Manual Control

THE accompanying illustrations show the De Florez system of remote control recently announced by the Brown Instrument Company, Philadelphia, Pa.

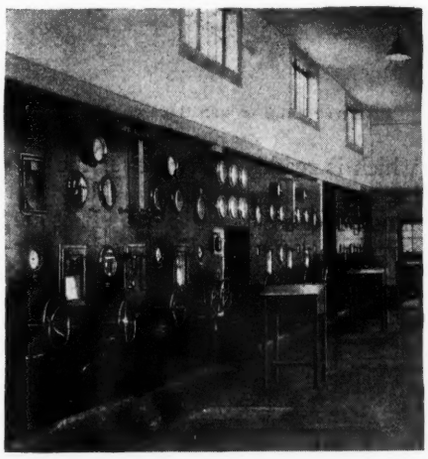
The system, which employs the Selsyn motor (self-synchronizing alternating-current), makes it possible for an operator to maintain manual control of a valve or other

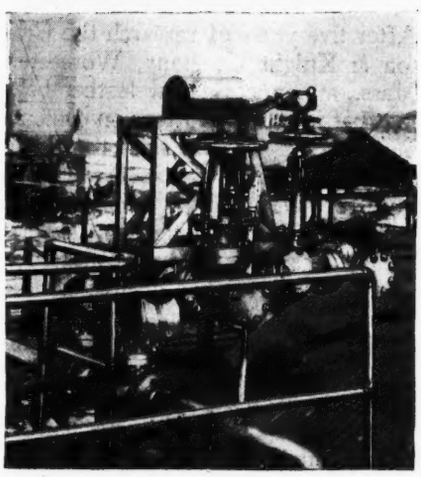


A General arrangement of transmitting and receiving unit

similar device from a distance. The actual work of opening or closing the valve is done by the operator in the control room or at some point distant from the valve, the power or work being transmitted between the two points by the Selsyn motors. The operating principle of these motors is too well known to require explanation.

Referring to the illustrations, the transmitting mechanism comprises a handwheel *A* which rotates the transmitting motor *B* through a gearing and through which the control is effected. As the armature of the motor *B* is rotated, by means of the handwheel, the armature of the receiving motor *C* is rotated a similar amount (by reason of the two being interconnected electrically and remaining in phase) the movement, in turn, being transmitted to the stem of the valve through gearing. With this arrangement, the power transmitted to the receiving mechanism is only that which is given to the transmitting wheel by the operator. Thus the resistance to motion can be felt and the amount of movement observed on the wheel in the same manner as when turning the valve itself.





View of control board and typical installation

The worm gear on the valve is attached to the stem by a clutch. A quickly detachable clutch *D* is inserted between the handwheel and the worm drive so that the mechanism can be disconnected quickly if desired to operate the valve independently. The drive shaft between the unit *C* and the valve is made flexible, so that the mechanism is equally well adapted to stationary and rising-stem types of valves.

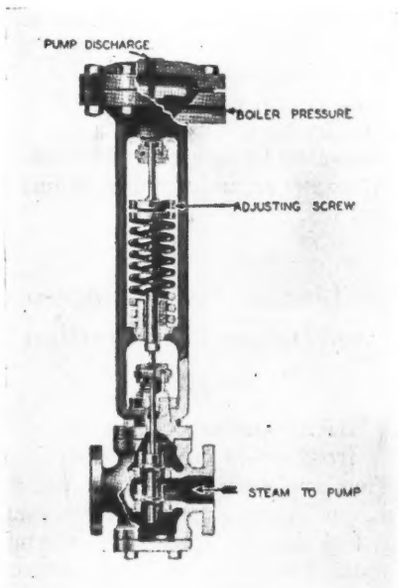
The transmitting unit is made up in small panels approximately 16x30 in. and can be bolted through control panels, or assembled in batteries. A pointer or indicator *E* is connected with the motor of the transmitting wheel to show the amount the system is turned, and a pilot light *F* is incorporated to show when the circuits are energized.

With suitable gearing the receiving unit *C* can be applied to practically any type of valve or to effect any rotary motion desired. The units can also be made to operate in any ratio desired to obtain close control.

Excess-Pressure Pump Governor With Improved Valve

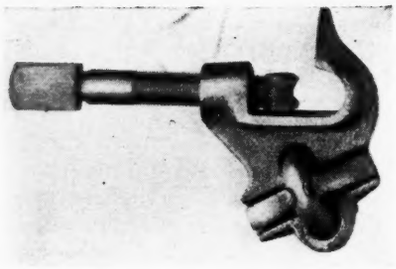
IN THE July 1 number mention was made of an improved valve, designated "Seatringuide," used with a piston-type pump governor put out by Neilan, Schumacher & Company, Santa Fe Ave., Los Angeles, Calif. This same valve in which the guides are on the seat ring in place of the disk is embodied in a new excess-pressure pump governor (No. 270) recently introduced by the same company.

In the governor illustrated the valve is opened by the boiler pressure, connected below a diaphragm and assited by an adjustable spring. These two forces are opposed by the pump discharge or boiler feed-line pressure connected above the diaphragm. When the pump discharge pressure reaches the combined pressure of the boiler steam and the spring it closes the valve to a point where the steam supplied to the pump is sufficient to maintain the desired excess pressure on the feed line. Greatly reduced frictional resistance and flow turbulence, with simplified regrinding, are among the claims made for this new valve.



Pressure governor for turbine and reciprocating pumps

Governors with bronze or cast-nickel-iron bodies suitable for pressures up to 200 lb. and with chrome-alloy cast-steel bodies for pump pressures of 300, 400, or 600 lb. are available. All governors are adjustable for excess pressures of from 10 to 60 pounds.



Clamp is used for making permanent connection

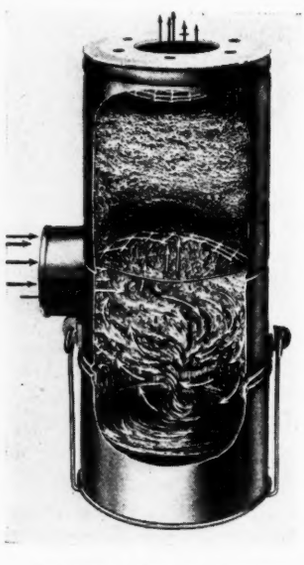
Improved Hot-Line Clamp

AN IMPROVED type of hot-line clamps for making permanent connections to switches, transformers, lightning arresters, cutting-in tap lines, jumpers on transformer lines, ground clamps, and in work on aluminum and copper conductors is illustrated. For normal distribution service it can be used to tap off individual transformers without installing disconnecting switches.

The clamp, put out by the Delta-Star Electric Company, Chicago, Ill., is operated by a hook stick, with a snap socket securely holding it during operation.

Air Cleaner for Compressors and Internal-Combustion Engines

THREE methods of removing dust from air—a vigorous centrifugal action, scrubbing through an oil spray and passing through an oil filter—are used in the air cleaner for internal-combustion engines and air compressors developed by the Vortox Manufacturing Company, Claremont, Calif. It consists of a chamber divided into two compartments separated by a baffle. The upper part is loosely filled with crimped wire, forming a metallic filter, and the lower part consists of a cup containing light engine oil.

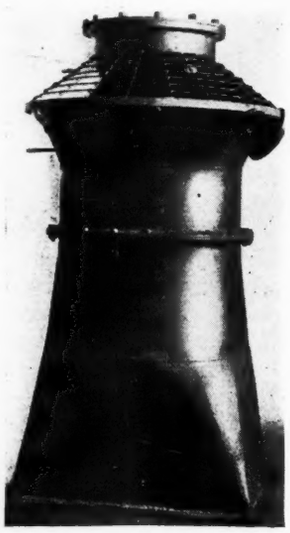


Cut-away view of cleaner

Air enters a tangential inlet nozzle, causing a whirling action which draws oil up from the cup. The centrifugal action of the whirling air tends to throw dust and oil particles outward against the walls of the cylinder, from which they wash down into the cup. Much of the dust is also caught directly by the oil spray, which fills the compartment. Small particles of foreign material which still remain in the air are caught by the metallic filter above. The wires in the filter are washed by the oil spray thrown up from below.

Turbine-Driven Propeller-Type Blower

LIGHT WEIGHT, high efficiency, and freedom from objectionable noise usually associated with small high-speed blowers, are claimed for the turbine-driven propeller-type forced-draft blower illustrated. This blower is rated at 8,500 c.f.m. at 2½-in. water static pressure. The propeller is three-bladed, and is driven by a single-wheel turbine with inside buckets milled in the wheel, through a steel shaft supported in grease-lubricated ball bearings.



Propeller-type forced-draft blower

These blowers may be installed in a horizontal or vertical position, or at any angle, and can be furnished with round, square or rectangular discharge duct. The unit is put out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Small Portable Ventilating Unit

ALTHOUGH designed primarily for ventilating cable manholes, the portable blower illustrated is equally suitable for ventilating underground passages in power plants, coal pockets, and for various other uses of cooling and drying.

It consists of a vano-type blower driven by a ½-hp. motor, the whole being mounted on a tripod with swivel joint. The diffuser outlet can be directed in a number of positions, and an 8-in. ventube (canvas tubing), which is readily slipped over the outlet, can be furnished. The unit illustrated weighs 115 lb. It is put out by the Coppus Engineering Corporation, Worcester, Mass.

Blower used to ventilate coal pocket

Leather Belt Made by New Process

UNTIL RECENTLY leather belting has been cemented by hand. After five years of research the Graton & Knight Company, Worcester, Mass., announces a new leather belting that is made by a tension cementing process. The joints in the single plys are cemented by a method that is said to give a high and uniform strength. When making two-ply belts the plys are cemented by a continuous machine process that insures a uniform product and eliminates the possibility of faulty workmanship.

The cement used is waterproof, extremely flexible, has a high heat crystallation point, and its mechanical application insures a stronger adhesion than is possible when the laps and plys are cemented by hand.

NEWS of the FIELD

Spot News

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AN OFFER *from a construction company of a larger salary than he could afford to forego is said to be the reason behind the request last week of Lieut.-Gen. Edgar Jadwin that he be not assigned to a place on the new Federal Power Commission. It is understood that General Jadwin received an offer from the concern, the name of which was not revealed, while on his recent trip around the world.*

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SUPPLYING *New York City with power generated from upstate water-power facilities, including the St. Lawrence River, was seen as approaching closer to realization when it was learned July 17 that engineers of the Niagara Hudson Power Corporation and of the New York Edison Company system have about reached a decision to link the vast hydro-electric plants of the state with the city's huge steam stations for the interchange of power.*

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CONSTRUCTION *was completed July 8 of the 2½-mile, 16-ft. tunnel, which is the first accomplishment in the development of the British Columbia Electric Railway Company's 500,000-hp. hydro-electric development at Bridge River, 150 miles north of Vancouver. Two and a half years have been spent in boring the tunnel, representing an outlay of $1,750,000 in labor and material.*

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APPLICATIONS *on the Colorado River that were rejected July 12 by the Federal Power Commission represent a total development of 17,000,000 hp. Five of them were rejected outright because they are in conflict with Boulder Dam. The remaining 21 applications were rejected subject to the right of appeal within 90 days, due to lack of rapidly increasing demand for power in the area.*

Need for International Ratings Stressed at Opening Session of I.E.C. Meeting

Cosmopolitan aspects of engineering make standard terminology a necessity for exchange of ideas, says Paul Larsen in address of welcome

By ELY C. HUTCHINSON
Special Dispatch to POWER

THE IMPORTANCE to world economics of international engineering nomenclature, ratings and standards of equipment manufacture was strongly stressed by Paul Larsen, chairman of the Danish Institute of Civil Engineers, in his address of welcome to delegates of twenty nations at the opening technical session of the International Electrotechnical Commission meeting in Stockholm, Sweden, on July 3. The session followed inaugural ceremonies at Copenhagen, Denmark, on June 27, and was part of the commission's seventh plenary meeting which was held in various parts of Scandinavia from June 27 to July 9.

"The science of engineering and the engineer's work," said Mr. Larsen, "are resting upon an international foundation, and, therefore form a link and a bridge between nations and carry the engineer far beyond the narrow boundaries of a linguistic and economic nature, which otherwise tend to isolate the nations from one another to their own detriment and prevent the attainment of a common happy future, which we all hope may be attained some day.

"The present generation has passed through a period of fight and sorrow, of losses and distress, unprecedented in the world's history, the deepest root of which is no doubt to be found in narrow economic and national interests in the various countries.

"And now by this time when all thoughts and efforts are directed towards finding means to heal the wounds and remedy all these terrible losses, now nearly all the nations turn again to the old methods of isolation trying to protect themselves against economic difficulties by building up high tariff walls around their own territories which can only prevent or make difficult a happy co-operation between the nations.

"In such a period it seems worth consideration to point out all efforts directed towards promoting such co-operation between all countries of the world which can contribute to strengthen them all and make them utilize their own natural resources in a constantly higher degree.

"In the attainment of this aim the work of the engineer has its great mission.

"The engineer is working everywhere through the same means, and his work can be carried out by everybody who possesses the faculty of exercising it, irrespective of his nationality, and the results of his work are of high economic value and of equal benefit to all nations.

"But to carry out his work internationally it is necessary for the engineer to speak a technical language which is understood and used all over the world.

"For the formation and development of such a language with a terminology to be used internationally, with common expressions for units of power and measures, the International Electrotechnical Commission has been founded, and, therefore, this commission is of the greatest importance as being a support for international engineering.

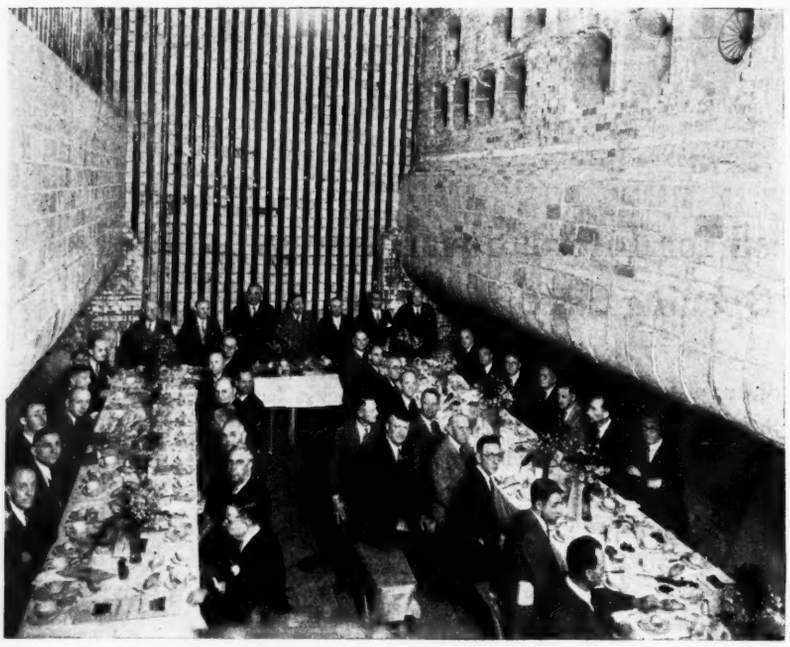
"AND WHEN I now on behalf of the Danish Institute of Civil Engineers bid all our guests heartily welcome to Denmark, then I beg to propose a toast to the International Electrotechnical Commission thereby expressing the engineers' gratitude for what the commission has accomplished for all engineering work and for all the different countries."

Though the work of the commission is not as well known in the United States as abroad where manufacturers depend more on foreign markets for the sale of their products, 30 delegates from this country were in attendance at the meeting and worked to have the rules passed acceptable to American manufacturers, in preparation for the day when they will be more active in foreign trade.

Other countries represented were: Austria, Belgium, Brazil, Canada, Denmark, France, Great Britain, Greece, Holland, India, Italy, Japan, Norway, Poland, Rumania, Sweden, Switzerland, Czechoslovakia and Russia.

Many of these countries are already closely watching the rules of the I.E.C. and are prompt to change their equipment in accordance with thoughts and features brought out in the meetings.

FIRST BANQUET IN HOG-FUEL FURNACE



BANQUETS have been held before in large boiler furnaces, but this is the first time such an event has taken place in a furnace designed to burn hog fuel.

Here we see executives and engineers of the Northwest Public Service Company dining in the furnace of a large boiler now nearing completion at Station L in Portland, Oregon.

The boiler is double-fired and is designed to produce 310,000 lb. of steam per hour with a consumption of 34 cords of hog fuel. It is the first furnace to employ water walls with such fuel. The oil burners shown in the upper right corner of the photograph are for emergency or supplementary use. Ordinarily, these will be blanked off with refractory blocks when the boiler is operating on sawmill refuse as it is planned to do most of the time.

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Promote Oil Conservation by Unit-Operation Law

To help the oil industry solve its wastage and overproduction problem, a law has been passed permitting unit operation of single oil fields. Up to the present, conditions have made operators race with each other to pump as much oil as possible through their wells lest their competitors draw out the remaining supply from beneath. The new law permits federal lessees and the government to enter agreements so that a given field can be tapped at leasure to meet demand and so that all holders will receive their share of petroleum without the wholesale waste now occurring. Leases can be extended beyond twenty years under the new law to remove the obstacle of expediency from the equation.

Secretary Wilbur has pushed the unit-operation plan principally to clear up the Kettleman Hills situation. Wastage of natural gas there is appling, it is stated by western observers. The hope is that, if this great and spectacular development can be lined up under the plan, other fields, private as well as under federal lease, will join the conservation movement. Government lessees occupying 30 per cent of the area of this rich field could not co-operate under former limitations.

Work Starts at Boulder Dam With Aerial Surveys

Active investigations preliminary to construction at Boulder Dam are being pushed by the Bureau of Reclamation now that the appropriation of $10,660,000 has been made available for this purpose. An initial step important in the planning of diversion works, placement of construction railway spurs, and the final location of the dam itself, will be the topographic mapping of Black Canyon on a scale of 50 ft. to the inch at 5-ft. contour intervals. This covers the canyon walls and the damsite.

Because of the steepness, it has been impossible to use ordinary ground methods with the desired accuracy. Vertical air photos would not solve the problem, because the whole canyon is in shadow. It was finally decided to use a photo-theodolite, taking pictures from ground stations tied in by triangulation and developing the plan and contours by use of the Aerocartograph stereoscopic instrument.

The proposed townsite to house project employees is being surveyed by aerial methods by Brock & Weymouth of Philadelphia. Reclamation engineers have completed their survey of the spur railroad location and are working to stake out the necessary highway connections. Reservoir surveys for capacity are complete, as are the plottings of small areas in the reservoir basin, where private claims, mostly for mining, will necessitate federal purchase before flooding.

A contract has been let for air mapping in the Palo Verde and Cibola Valley areas, downstream from Black Canyon. The purpose is for dike and ditch layout on the Parker-Gila project and to determine the backwater effect when a diversion dam has been built for the all-American canal.

To Vote on Bond Issue

A power bond issue for the Los Angeles Bureau of Power and Light has been proposed for the city primary election of Aug. 26. Two proposals have been prepared by E. F. Scattergood, chief engineer of the bureau, and these proposals have been presented to the mayor for his consideration. One of these proposals is said to provide for a $19,000,000 power bond issue, while the alternate proposal calls for a considerably larger sum. Preliminary work on a transmission line from Boulder Canyon to Los Angeles, including a survey and possibly certain rights-of-way purchases, are said to be provided for in the latter bond issue.

Fresno, Calif., May Run Own Gas and Electric Plants

What is regarded as the first step toward the municipal ownership of gas and electric utilities in Fresno, Calif., was the recent announcement by officials of that city that negotiations had been opened with three large California oil companies for the purpose of obtaining options on gas lands sufficient to supply not only the gas needs of the community, but the electrical needs as well. The plans contemplate the use of natural gas to generate electrical energy.

The decision to obtain proposals for options on gas property was arrived at by the city commission following a meeting in Tulare, Calif., at which B. F. DeLanty, general manager of the Pasadena Municipal Light & Power Department, told of Pasadena's successful experience in using natural gas in the generation of electricity. He stated that in the past 23 years Pasadena has made large profits in the manufacture and sale of electricity, at the same time has provided low rates and a satisfactory service to consumers, and has been able by this means to cut its tax rate down to one dollar a hundred.

New York Museum to Depict Rise of Machine Age

The story of the rise of the machine age will be told in a special educational exhibit based on the theme of "Men and Machines," to be held this fall by the Museums of the Peaceful Arts, New York City's museum of science and industry, it was announced July 14 by Frederic B. Pratt, president of the Museums and of the Pratt Institute, Brooklyn.

The special exhibit, according to Mr. Pratt's statement, will be held in the new quarters of the Museums in the News Building, 220 East 42d Street, from Sept. 12 to Nov. 15, and will mark an important expansion of the Museums' educational activities. It will present a dramatic epitome of the scientific discoveries, inventions, and machine improvements which in a period of fifteen decades have effected a world revolution in industry and society. Nearly 100 American corporations are co-operating in assembling the special exhibits.

"Plans of the exhibit," Mr. Pratt said, "pose three objectives. The first is to present the chief physical agencies of the new machine age, with emphasis on the growth of metallurgical science and the development of power and the machine tool. The second is to present the most significant of the industrial advances which these have brought about; consequently a wide range not only of early and present-day industrial machines, but of their products will be included. The third objective is to indicate as far as practical, the social and economic significances of the great technological advances.

"Power will be depicted as the life blood of the machine age. We will show, in various forms, Watt's steam engine, modern steam engines, the internal-combustion engine, electrical current transmission, the development of the central power station, water power development, and other items pertinent to the field."

Discuss Further Plans for Hydraulic Laboratory

Further plans for the National Hydraulic Laboratory were discussed on July 14 and 15 at the Bureau of Standards in Washington as the special advisory committee of hydraulic engineers and federal officials held its second meeting. Since some of the preliminaries had been lined up three weeks before, when John R. Freeman submitted detailed plans and estimates, the committee members came ready to discuss technical points of the laboratory layout, equipment, operation, and purposes. Dr. Freeman, now in Europe, as are two of the other members, was represented by A. C. Chick, of his staff, who presented further material for consideration.

No final decisions have been reached, since such problems as the quantity of water to be used require extensive studies before a commitment is made. It is expected that the design will be finished about next September and that contract will be let shortly thereafter, according to Dr. G. K. Burgess, director of the bureau.

A resolution was passed tendering appreciation to Senator Joseph E. Ransdell of Louisiana, whose continued legislative efforts were largely responsible for the laboratory appropriation. This message was presented at a dinner given the Senator by the Louisiana Society of Engineers July 21 in New Orleans, in recognition of the services he performed as sponsor for the hydraulic laboratory bill on its way through Congress.

Steam Tables Conference at Berlin, a Success

The Berlin meeting of the International Steam Tables Conference came to a close in the forenoon of June 26, after a successful four days' session.

Following the opening preliminaries a tribute was paid to Professor H. C. Callender of the British committee, who died the latter part of 1929. A working committee was then appointed to make recommendations as to the acceptable values and tolerances in the skeleton tables previously worked out. The figures agreed upon were accepted by the committee of the whole at its last meeting.

The next meeting of the conference will take place in the United States during the fall of 1932, it was announced.

News of Canada

Negotations on St. Lawrence development may soon be resumed—Final Plans for Pend Orielle project filed

RESUMPTION of Canadian-American negotiations on the St. Lawrence seaway and power project is expected to take place soon after the elections in Canada next week. The last big obstacle in the way of the project, is a 48-mile stretch of the river in the international rapids section, where the greatest power resources lie. This section of the river cannot be developed either for navigation or for power until a treaty has been negotiated and ratified by Canada and the United States. Two attempts to draft such a treaty have been made since 1926 without success.

Copies just issued of the report of negotiations between members of the Canadian section of the Joint International Board of Engineers and representatives of the Ontario Hydro-Electric Power Commission, who investigated the deep-water and power possibilities of the international rapids section of the river, indicate Canada's present partiality toward a double-stage navigation and power project costing about $274,020,000, with an installation of 2,199,960 horsepower.

The development recommended in the present report differs in some minor respects from the double-stage scheme suggested by the Canadian engineers in their conferences with the United States

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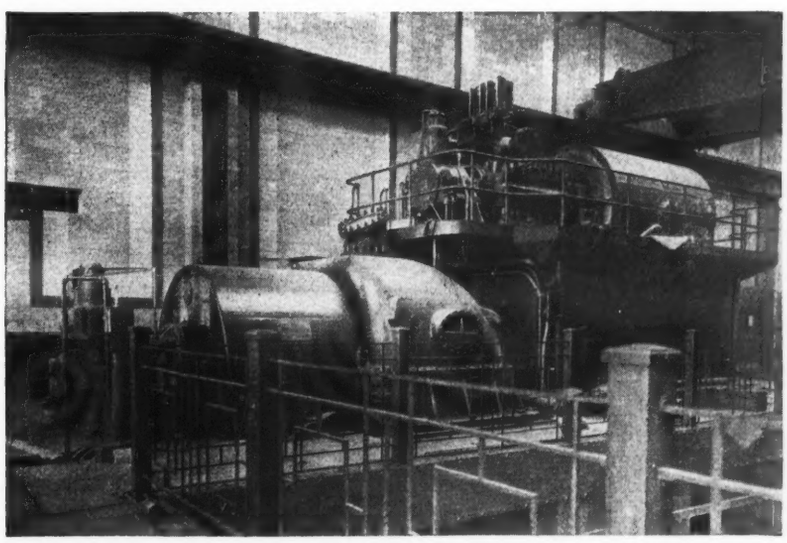
COMPLETE 1,400-LB. SOUTH AMBOY PLANT



The first section of the new 270,000-kw. high-pressure station of the Jersey Central Power & Light Company, at South Amboy, N. J., nears completion with the installation of two General Electric 25,000-kw., 1,250-lb. steam pressure, vertical-compound turbine-generators, the first of this type to be installed. Design details of this station's equipment, which includes three 7,214-sq.ft. boilers operating at 1,400 lb., were given in *Power*, May 28, 1929.

section of the board several years ago. The previous report contemplated a double-stage development scheme with the first stage at Ogden Island, near Morrisburg, and the lower one at Barnhart Island, 2½ miles above Cornwall. Subsequent investigations have led the Canadians in their present report to recommend the alternative project of installing the first stage at Crysler Island, 3 miles downstream from Morrisburg, in preference to Ogden Island. The second stage remains, as before, at Barnhart Island.

COMPLETE PLANS for the development of power sites on the Pend Oreille River have been filed by the West Kootenay Power & Light Company with the Water Board in Victoria, B. C. The plans, which call for one of Canada's greatest hydro-electric developments, will be considered at a public hearing to be held about the end of July. Final plans call for construction of two dams, one at the junction of the Pend Oreille with the Columbia, and one further upstream. Together, the two dams would control the entire flow of the river, capable of developing 150,000 hp., with maximum part-time development of 275,000 horsepower.

The time-worn fight between the West Kootenay company and the Reeves Macdonald Mining Company will be renewed at the forthcoming public hearing, with the two concerns battling for the control of the river. Efforts to effect a settlement between them by the government have failed.

General Electric to Build Blue-Sky Laboratory

A blue-sky laboratory where research engineers of the General Electric Company will be able to make tests of transmission line equipment under natural conditions is to be erected at Pittsfield, Mass. The new outdoor experimental room will be operated as a separate unit from the famous artificial lightning laboratory where 5,000,000-volt flashes have been created.

In the new laboratory it will be possible for the elements to vent their spite upon newly designed equipment and so provide engineers with information vitally necessary to improve designs. No longer will the engineers have to wait until equipment is in actual service to find out what wind and rain, storm and sunshine can do to it. It will be possible to learn right on the spot in the variable Berkshire weather.

Practically all equipment associated with the production and use of transmission lines at high or low voltages can be tested in the new laboratory. Three transformers in chain will be installed. These will be designed for continuous operation at full voltage. In this manner tests may be run outdoors for a considerable time, especially when weather changes are expected that will furnish valuable data.

WORLD'S SMALLEST

What is believed to be the world's smallest synchronous electric motor is shown by C. E. Skinner, assistant director of engineering for the Westinghouse Electric & Manufacturing Company. About the size of a hickory nut, it runs on ordinary house current and is rated at approximately one-half cricket power. This motor is used in delicate devices which require a constant speed with very little power

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How's Business?

THE PASSING of the mid-year spurt, marked by unusually high levels of building contracting and money turnover, has left business facing the full force of the usual July slackness now emphasized by a depression year. Our index, after touching normal for a brief period at the end of June, has receded, as expected, to 97.2 per cent. Furthermore declines will probably be shown in the remaining weeks of the month. Industrial activity, apart from building, is at the lowest level of the year, but general trade though slackening somewhat with the season, continues well sustained in comparison with production. Commodity prices, except in key agricultural products, show greater steadiness here and especially abroad. The stock market is showing encouraging resistance to further liquidation at a time when it is least expected, and business sentiment has a better tone. The excessive pessimism of recent months, based on roseate memories of last year, will have progressively less to feed upon as we pass the end of July.—*The Business Week*, July 23.

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Personals

HOWARD HARDING, mechanical engineer with the Rochester Gas & Electric Corporation, was recently elected treasurer of the Rochester Engineering Society.

JAMES WHITE, formerly secretary of Jenkins Brothers, has been made vice-president and director of sales of the corporation.

FRANK PURSE, engineer, of Tacoma, Wash., and a former member of the Civil Service Commission of that city, has been appointed state supervisor of public utilities, a post that has been vacant since last August, when C. REA MOORE resigned.

ARTHUR W. BERRESFORD, past president of the American Engineering Council, received the first prize in the annual Phebe Hobson Fowler professional award, in recognition of his particularly efficient administration of the council. The prize, a gold-bronze medal, was presented to Mr. Berresford at the recent annual convention of the American Society of Civil Engineers.

J. B. BROKAW, since 1924 chief engineer of the Eastern Oregon Light & Power Company, Baker, Ore., has resigned to accept the position of assistant manager with the Peoples West Coast Hydro-Electric Corporation, California Public Service Company, and Western States Utilities Company, with headquarters in Portland, Ore. These companies are subsidiaries of the Peoples Light & Power Company, New York.

J. R. SNIDER, veteran southwest Washington utility executive, is the new vice-president and general manager of the Grays Harbor Railway & Light Company, according to a recent announcement of the company. Mr. Snider has been connected with the power industry in western Washington since 1912, when he was identified with the Sanderson & Porter interests in development work on Willapa harbor.

H. C. GOODRICH, chief engineer of the Utah Copper Company, was elected president of the Utah Society of Engineers, at the annual outing and election of officers of that organization held in Salt Lake City recently. Other officers chosen were: C. H. JONES, first vice-president; DORSEY A. LYON, second vice-president; RALPH R. WOOLLEY, secretary; and R. K. BROWN, treasurer.

HARLEY L. CLARKE, president of the Utilities Power & Light Corporation of Chicago, has been elected to the board of directors of the American Arbitration Association.

ALBERT B. STEVENS, petroleum engineer, has been added to the faculty of the University of Southern California as instructor in general engineering.

Business Notes

WILLIAM B. FERGUSON, consulting engineer, is now located at 89 Broad St., New York City, Rooms 301 and 305.

BOILER ENGINEERING COMPANY, Newark, N. J., announces the appointment of G. L. Simonds, Winter Haven, Fla., as its representative in the State of Florida.

B. F. STURTEVANT COMPANY, Hyde Park, Boston, Mass., announces the removal of its Minneapolis branch office from 1024 Metropolitan Life Building to 874-875 Northwestern Bank Building, Minneapolis, Minn. P. A. Dwyer will remain in charge.

GENERAL REFRACTORIES COMPANY, Philadelphia, Pa., announces the removal of its Detroit sales office to 2328 Union Trust Building, Detroit, Mich.

ROSS HEATER & MANUFACTURING COMPANY, Buffalo, N. Y., announces the new location of its Chicago district office as Room 1518, 20 North Wacker Drive, Chicago, with S. Wolff as district manager and R. E. Allen, sales engineer.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces that the industrial heating and welding section of its industrial department has been divided into two sections. C. L. Ipsen is manager of sales of the industrial heating section, and L. D. Meeker is manager of sales of the electric welding section.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, announces the promotion of J. L. Van Nort to sales engineer of its Boston, Mass., office.

AMERICAN DISTRICT STEAM COMPANY, North Tonawanda, N. Y., announces the appointment of Henry C. Hill as its Cincinnati district sales representative.

CHICAGO PUMP COMPANY, Chicago, Ill., announces the addition to its list of representatives of R. J. Welsh, 503 Healy St., Atlanta, Ga

NORTH AMERICAN REFRACTORIES COMPANY, Cleveland, Ohio, announces the purchase of properties and assets of the UNITED STATES REFRACTORIES CORPORATION, Mt. Union, Pa., and the SAVAGE MOUNTAIN FIRE BRICK COMPANY, Frostburg, Md. The acquisition increases the annual production capacity of the North American company to approximately 200,000,000 9-in. equivalent refractories.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., announces the combination of the sales office and service station for the Atlanta territory and the installation of both in the new fireproof building at 14-20 Alexander St., N. W., Atlanta, Ga. The same personnel will be in charge.

Coming Conventions

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual Pacific Coast convention at Portland, Ore., Sept. 2-5. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

Trade Catalogs

FEEDWATER TREATMENT — The National Aluminate Corporation, 6216 West 66th Place, Chicago, Ill., has recently issued three illustrated bulletins on the problems of boiler water treatment: No. 9A, entitled "A Flexible and Scientific Method of Treating Feedwater in the Boiler"; No. 26, on the "Benzidine Method for Determining Sulphates in Water"; and No. 12B, on "How to Increase the Efficiency of Lime and Soda Ash Softening Plants."

PUMPS—Bulletin 107 of the M. T. Davidson Company, 154 Nassau St., New York City, describes and illustrates Type AY, single-stage, double-suction, centrifugal pumps for general service.

FLUE GAS ANALYZERS—In a new 20-page catalog, The Hays Corporation, Michigan City, Ind., presents the outstanding features of its new model flue-gas analyzers and the combustion test sets, in which the following instruments may be obtained separately or in combination: draft gage, thermo gage, thermometer, and manometer.

MOTORS — Synchronous motors and converters are described and illustrated in four new leaflets of the General Electric Company, Schenectady, N. Y.: GEA-1195 on synchronous motors for driving metal-rolling mills; GEA-792A on synchronous motor-generator sets for mining service; GEA-246B on general purpose synchronous motors; and GEA-1270 on synchronous converters for mining service.

CONVEYORS — The new "Steamatic" pneumatic ash conveyor system is fully described and illustrated in a recent publication of the United Conveyor Corporation, Old Colony Building, Chicago, Ill.

METERS—Catalog GEA-615 of the General Electric Company, Schenectady, N. Y., presents complete information on various types of watthour meters. Another recent folder of the company, GEA-55B, describes and illustrates round-pattern switchboard instruments.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.25 @ $2.50
Kanawha	Cincinnati	.90 @ 1.10
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	1.75 @ 2.00
West Kentucky	Louisville	.85 @ 1.25
Steam	Pittsburgh	1.30 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75
Anthracite		
(Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.15 @ 1.50

FUEL OIL

New York—July 17, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6@6.25c. per gal.

St. Louis—July 9, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.370 per bbl., or 42 gal.; 26@28 deg., $1.495 per bbl.; 28@30 deg., $1.570 per bbl.; 30@32 deg. $1.625 per bbl.; 32@36 deg., gas oil, 3.9c. per gal.; 38@40 deg., distillate, 4.86c. per gal.

Pittsburgh — July 9, f.o.b. local refinery, 30@34 deg., fuel oil, 3.12½c.@3.25c. per gal.; 36@40 deg., 3.25c.@3.5c.

Philadelphia—July 12, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — July 14, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—July 11, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 77.5c. per bbl.; 30@32 deg., $0.95 per bbl.

Boston—July 14, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.33c. per gal.; 28@32 deg., 5c. per gal.

Dallas—July 12, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Phoenix—Camelback Water Conservation Dist., c/o Reed & Baker, Engrs., Fleming Bldg., Phoenix, making preliminary plans for eight 20 in. wells equipped with 150 hp. deep well turbine pumps and motors, seven 10 to 200 hp. booster pumps, 8 in. 11,000 volt transmission line, etc. Estimated cost $425,000. Plans now before the State Certification Bd. of approval.

Calif., Pasadena—City plans the construction of a municipal lighting plant at Glenarm St. Estimated cost $150,000. Bennett & Haskell, 311 1st Trust Bldg., is architect.

Calif., Stockton—Pacific Gas & Electric Co., 245 Market St., San Francisco, plans the construction of a 100 x 150 ft. garage, warehouse, shop buildings, storage sheds and additional equipment for substation at Church and Center Sts. Estimated total cost $500,000. Private plans.

Connecticut—Connecticut Power Co., 185 Church St., New Haven, awarded contract for the construction of a 1 story power sub-station between Hamden and West Haven to National Constr. Co., 152 Temple St., New Haven. Estimated cost $40,000 or more.

Idaho, Soda Springs—City plans election July 29 to vote $30,000 bonds for municipal hydro-electric plant. L. Stewart is city clerk.

Ind., Bedford—City plans the construction of a pumping station on White River. Estimated cost $16,000. H. McIntyre, Bedford, is engineer.

Ind., East Chicago—Northern Indiana Public Service Co., awarded the general contract for the construction of 2 story, 35 x 75 ft. and 1 story, 36 x 60 ft. power substations to H. B. Olney, 1200 East Chicago Ave., East Chicago. Estimated total cost $75,000.

Mass., North Reading—Commonwealth of Massachusetts, Dept. Public Health, Boston, awarded contract for altering and equipping power house at state sanitarium, to Acme Heating & Ventilating Co., 13 Hawkins St., Boston. Estimated cost $40,000.

Mass., Springfield—Springfield Hospital, 759 Chestnut St., and Stevens & Lee, Archts., 45 Newbury St., Boston, will receive bids until July 25, for the construction of a 7 story and basement, 60 x 200 ft. hospital and 2 story, and basement, 50 x 241 ft. service building, including heating and ventilating, plumbing and electric work at North Chestnut and Springfield Sts. Estimated cost $1,075,000.

Mo., St. Louis—Terminal Railroad Association, 1800 Market St., will receive bids about Aug. 1, for the construction of a 13 and 16 or 18 story and basement, 330 x 358 ft. merchandising mart at Spruce, 12th, 13th and Poplar Sts. Estimated cost approximately $5,000,000. W. J. Knight & Co., Wainwright Bldg., are engineers. Private plans. St. Louis Mart, Inc., c/o H. C. Martin, 315 North 10th St., is lessee.

Nev., Reno—J. B. Reese, Clk., awarded the contract for the construction of a sewage treatment plant, pumping station, etc., to Christensen & Co., Reno, $329,940.

N. J., Asbury Park — Morris & Erskine, Archts., 1716 Chestnut St., Phila., Pa., received lowest bid general contract for the construction of a 5 story and basement, hospital, nurses home and boiler house at Corliss Ave., from Walter Kidde & Co., 140 Cedar St., New York, for Ann May Memorial Hospital, c/o A. J. Ackerman, Pres. Estimated total cost $1,100,000.

N. J., Hackettstown — Centenary Collegiate Institute, Church St., awarded general contract for a 1 story and basement boiler house at Church St., to James Mitchell Inc., 26 Journal Square, Jersey City. Estimated cost $40,000.

N. Y., Buffalo—Buffalo Terminal Co., Buffalo, will soon award the contract for the construction of terminal buildings, including refrigerating warehouses, etc., at Bailey Ave. and Clinton St. Estimated cost $500,000. George S. Rider Co., Marshall Bldg., Cleveland, O., is architect.

N. D., Grand Forks — City voted $225,000 bonds, to improve and extend waterworks, including pumping station. Burns & McDonnell, 403 Interstate Bldg., Kansas City, Mo., are engineers.

Oklahoma, Texas and Kansas—Cities Service Gas Co., Bartlesville, Okla., will construct a 4,000 hp. natural gas compressor station near Seminole. Estimated cost $150,000; 1,000 hp. on pipeline at Mooreland, $75,000; 5,000 hp. near Blackwell, $60,000, all Oklahoma; 2,000 hp. near Higgins, Tex., $90,000; will construct a 32 mile natural gas pipeline north from Blackwell, Okla., to a point near Wichita, Kan. Estimated cost $100,000. Private plans.

Pa., Saxonburg — Westinghouse Electric & Manufacturing Co., East Pittsburgh, plans the construction of an addition to transmitting station KDKA, output 400,000 watts. Estimated cost $172,000. B. H. Prack, Martin Bldg., N.S., Pittsburgh, is architect.

Pa., Sewickley—Duquesne Light Co., 435 6th Ave., Pittsburgh, has work underway on the construction of a 1 story sub-station, Shadwick and White Sts. Estimated cost $150,000. Byllesby Engineering & Man. Corp., 435 6th Ave., Pittsburgh, are engineers.

Pa., South Oil City—Pennsylvania R.R. Co., T. J. Skillman, Ch. Engr., Broad Street Station, Phila., plans the improvement of engine house facilities including rearrangement of power plant, etc. Estimated cost $300,000.

Tex., Denton—City Commission soon awards contract for the construction of a municipal ice plant, 25- or 50-ton unit for the treatment of raw and distilled water.

Tex., Mercedes—American Rio Grande Land Irrigation Co., plans irrigating 10,000 acres known as the North Capisallo Tract, including pumping unit, etc., near here. Estimated cost $500,000.

Tex., Mercedes — Owen Combe, et al., 642 Washington St., Brownsville, has been granted permit for preliminary surveys to irrigate 150,000 acres, involving 2,000 hp. hydro-electric plant, large pumping plant, etc. $1,500,000. Private plans.

Tex., South San Antonio—City, J. C. Everett, Mayor, making plans and surveys for extending distribution system into outlaying districts, including pumping unit, etc. Estimated cost $100,000. Municipal Engineering Co., Athletic Bldg., Dallas, is engineer.

Vt., Partland—Treasury Dept., Wash., D. C., is receiving bids for the repairs, including heating plant and elevators, at marine hospital. J. A. Wetmore, Treasury Dept., Wash., D. C., is architect.

Wash., Montesano — City voted $110,000 bonds to purchase and improve waterworks of the Puget Sound Power & Light Co. A. S. Campbell has been named superintendent.

Wash., Seattle—City, awarded the contract for the excavation for the new light and power house at Diablo on the Skagit River, on cost plus basis, also surge tank and power tunnel, to Rumsey & Jordan. $64,000.

Wash., Tacoma — Bd. Contracts & Awards, awarded contract for the construction of steel frame for the Lake Cushman power plant 2 on the southwest side of Hylebos Waterway, to C. F. Larson, Tacoma, $41,822. Estimated cost $350,000.

Ontario—Hydro-Electric Power Comn., F. A. Gaby, Ch. Engr., 180 University Ave., Toronto, plans the construction of sub-stations and equipment. Installing three 1,000 kva. transformers at Barrie; increasing from 100 kva. to 450 kva. at Fennels Corners; new 1,500 kva. transformer at Hespeler; 450 kva. sub-station at Thorold; 300 kva. sub-station and equipment at Painswick and Utterson; and 50 kva. at Fergusonale. Estimated cost to exceed $50,000.

Ont., Lucknow—City voted $71,200 bond, to install waterworks, including electric centrifugal pumps. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, are engineers.

Ont., Toronto—Hydro-Electric Power Comn., F. A. Gaby, Ch. Engr., 180 University Ave., plans the construction of a 220,000 volt sub-station to handle 200,000 hp. which is being developed on the Ottawa River at Chats Falls; will probably add sufficient capacity at Leaside Station to handle the additional load. Estimated total cost $1,500,000.

Equipment Wanted

BOILERS, etc.—**Cincinnati, O.**—Dept. of Public Welfare, H. H. Griswold, Dir., 9th and Oak Sts., Columbus, receiving bids for four 300-hp. boilers; one 150 and two 200-hp. generator engines and other equipment for new power house at Longview State Hospital.

STOKER, etc.—**Cleveland, O.**—City is receiving bids until July 25 for furnishing stoker, platform scales, coal and ash handling equipment for boiler house at City Infirmary. F. H. Cover, 502 City Hall, is city engineer.

DIESEL ENGINES—**Norman, Okla.**—City Comrs. receiving bids for two diesel engines and two belt connected centrifugal pumps for Water Dept.

ICE MANUFACTURING EQUIPMENT—**Owen Sound, Ont.**—Owen Sound Arena Ltd., R. Patterson, Pres., interested in prices for complete equipment for the manufacture of artificial ice for arena. Estimated cost $50,000.

EQUIPMENT — West Texas Utilities Co., Abilene, Tex., has acquired waterworks and light plant at Texaline. Surveys will be made for improvements, including new equipment in engine department, etc.

POWER PLANT EQUIPMENT—**Pierre, S. D.**—City voted $125,000 bonds, for addition to power plant and equipment, including two 600-hp. Diesel engines. R. Baker is city engineer.

POWER PLANT EQUIPMENT—**Toledo, Ia.**—Iowa Railway & Light Corp., F. C. Chambers, Genl. Mgr., 201 2nd Ave., Cedar Rapids, equipment, including diesel engine-driven generators, necessary transmission lines, etc. for power plant, plans under way.

POWER HOUSE EQUIPMENT — **Skillman, N. J.**—Dept. of Institutions & Agencies, State Office Bldg., Trenton, will receive bids about Aug. 1, for power house equipment, including boiler stokers, smoke stack, coal and ash handling equipment at State Village of Epileptics. Estimated cost approximately $25,000. C. N. Leathens, State Office Bldg., Trenton, is division architect.

TURBINE and EXCITER—**Chillicothe, Mo.**—City will receive bids until Aug. 5, for a 1500 kw. turbine, surface condenser and a 25 kw. turbine driven exciter. E. E. Harper, 4010 Penn Ave., Kansas City, Mo. is consulting engineer.

Industrial Projects

Calif., Watsonville—Gay Engineering Corp., Engineers, 2650 Santa Fe Ave., Los Angeles, receviing bids for the construction of a cold storage plant at Beach Rd., for Apple Growers Cold Storage Association. Estimated cost $70,000.

Ind., Logansport—R. B. M. Manufacturing Co., will build addition to plant, here. Estimated cost $40,000. Private plans.

Ind., Terre Haute—American Can Co., Terre Haute, is receiving bids for the masonry, carpentry and concrete work for a 3 story and basement, 180 x 350 ft. factory, including 50 x 60 boiler house and equipment. Estimated cost $1,000,000. Private plans.

Md., Curtis Bay — Commercial Pigments Corp., Curtis Bay, and 230 Park Ave., New York, awarded contract for the construction of additional buildings, including a 70 x 92 ft. machine shop, to United Engineers & Constructors, 112 North Broad St., Phila., Pa. $200,000.

Mass., Chicopee—A. G. Spaulding & Co., Chicopee, awarded the contract for the construction of a 1 story, 60 x 200 ft. refinery, to W. A. Newton Co., Mill River Lane, Springfield. Estimated cost $40,000 to $50,000 .

Okla., Guthrie — City voted $225,000 bonds for gas plant.

Mass., North Andover—Meadowbrook Laundry Co., is receiving bids for the construction of a 1 story power house. Estimated cost approximately $40,000. H. Petzold, Bay State Bldg., Lawrence, is architect.

N. H., Dover—Parle Ice & Coal Co., Kirkland St., receiving bids for the altering and constructing 2 story addition to ice plant. Estimated cost $40,000. A. W. K. Billings, Jr., 80 Boylston St., Boston, Mass., is architect.

O., Cleveland—W. S. Tyler Co., E. P. Disbro, vice-pres., 3613 Superior Ave., manufacturers of ornamental iron and bronze, awarded contract for the construction of a 3 story, basement, 70 x 106 ft., factory, at East 36th St. and Superior Ave., to Aronberg-Fried Co., Terminal Tower. Estimated cost $100,000.

Okla., Sayre—Oklahoma Carbon Manufacturing Co., will build a carbon black plant, here. $60,000. F. L. Coogan, Sayre, is engineer.

Okla., Sayre — Westoak Gasoline Co., will build a casinghead gasoline plant, near here. $75,000. F. L. Coogan, Sayre, is engineer.

Pa., Ambridge—Spang Chalfant & Co., Etna and Ambridge, will soon award the contract for the construction of a mill for electric welding process. Estimated cost $2,000,000. Private plans.

Pa., Pittsburgh—Atlantic Refining Co., W. J. Patterson, Sales Mgr., Pittsburgh Dist., 5733 Butler St., Pittsburgh, is receiving bids for the construction of a 2 story, 44 x 77 ft. boiler house, 5732 Butler St. Estimated cost $40,000. W. Samons, 3144 Passayunk Ave., Phila., is company engineer.

W. Va., New Cumberland—Cronin China Co. and Associates, will receive until about Aug. 13, for the construction of a 1 story factory addition, including bisque gloss kiln. Estimated cost $40,000. Private plans.

Ont., Waterloo—Waterloo Manufacturing Co., awarded general contract for the construction of a 1 story, 100 x 250 ft. factory for the manufacture of "combines" combination binder, thresher, etc., to John V. Gray Constr. Co., 1602 Northern Ontario Bldg., Toronto. Estimated total cost $100,000. Complete equipment to be installed.